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The American Midland Naturalist

Founded by J. A. Nieuwland, C.S.C.

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The Boletoideae of Florida

The Boletineae of Florida with Notes on Extralimital Species III.[1]

Rolf Singer

The Boletoideae are the central group of the Boletaceae, the most typical representatives of what we commonly call boletes. In general appearance, they resemble most closely *Boletus edulis* Bull. *ex.* Fr., the type of the genus *Boletus* which in its turn is the nomenclatoral type of the family Boletaceae and the subfamily Boletoideae. The preceding papers on the Boletineae of Florida dealt with the less typical "boletes," *i.e., forms* that are aberrant in important characters either of the spores and hymenium (Strobilomycetaceae), or in having clamped hyphal septa (Gyrodontoideae), or forms belonging to that characteristic type of obligatory symbionts of conifers (Suilloideae), or to a group with atypical tramal structure.

The Boletoideae are, as far as the number of species is concerned, by far the largest subfamily of the Boletaceae in Florida. This is in striking contrast with such boreal regions as most of Canada, the northern part of the Rocky Mountains, or Siberia where the Suilloideae undoubtedly maintain the first place in abundance and in importance. On the other hand, the genus *Boletus* and allied genera are supposed to be rare in tropical regions. Actually there seems to be a belt reaching from New Jersey south to North Florida where the number of boletoid species is unusually high, only to diminsh both southward and northward without, however, disappearing wholly in either the tropical or in the boreal zone. The number of species is much higher in this continent than in Europe. Florida alone has 39 species of Boletoideae, not counting the species which are imperfectly known, and omitting the subspecies and varieties.

As for the determination of the genera (*Phlebopus, Pulveroboletus, Boletus, Xanthoconium, Tylopilus, Leccinum*) the reader is referred to the keys in part II[2] of *Boletineae of Florida* (Farlowia 2:225-230. 1945).

Subfamily **Boletoideae**, subfam. nov.

Fungi familiae Boletacearum, characteres subfamiliae Suilloidearum (Farlowia 2:250. 1945) haud reunientibus, tramate typice bilaterali-divergente;

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1 The first two monographs on Florida Boletineae, treating the Strobilomycetaceae and the Boletaceae subfamilies Gyrodontoideae, Suilloideae, and Xerocomoideae have appeared in Farlowia **2**(1):97-141. 1945 and Farlowia **2**(2):223-303. 1945. A fourth monograph, on the lamellate Boletineae, has appeared in Farlowia **2**(4):527-567. 1946.

2 The numbers in parentheses preceding the genera are those of the keys.

hyphis haud fibuligeris; sporis haud flavis in cumulo atque ellipsoideis submicroscopio; hymenophoris nunquam lamellosis.

Characters of the subfamily: see key, Farlowia, *l. c.* and the above Latin diagnosis. The type genus is *Boletus* Dill. *ex* Fr. *em.*

1(10). PHLEBOPUS (Heim) Sing., Ann. Mycol. 34:326. 1936.

Boletus subgenus *Phlebopus* Heim, Rev. de Mycol. 1:6. 1936.

Characters of the genus: The genus *Phlebopus* is represented by two species in Africa and at least two more in Asia, Europe and America where, however, the most striking characters of the stipe on which the genus was founded are almost completely lost. They thus become very similar to the species of *Pulveroboletus* from which they differ in the shape of the hymenophore which consists of relatively short to medium long tubes with a concave-arcuate lower surface at least in young specimens. The tubes are distinctly decurrent or at least show a decurrent tooth; they are never depressed around the stipe. The mycelium is very abundantly developed around the base and quite frequently forms some kind of pseudosclerotium. The context frequently changes to blue when injured. There is no veil. The African species, in addition to these characters have a conspicuously furrowed stipe. The spores of most of the species are ovoid-ellipsoid but in some forms of *P. sulphureus* they are more elongate, often cylindric. The type species of the genus *Phlebopus* is *Boletus* (*Phlebopus*) *colossus* Heim.

KEY TO THE SECTIONS

A. Stipe furrowed below. On the earth and on the base of *Coffea*-trunks. African species ..... Sect. *Colossi*

A. Stipe scarcely or not furrowed on the base. On trunks and stumps of trees, also on sawdust (conifers, *Acacia*). Not occurring in Africa, at least not in tropical Africa ..... Sect. *Sulphurei*

Section **Colossi**, sect. nov.

Stipite basin versus canaliculato. Species Africanae.

Characters of the section: see key and Latin diagnosis. The type species is *P. colossus* (Heim) Sing. The disposition of this latter species has been made by this writer on the assumption that the shape of the spores (Heim, *l. c.*, p. 11, *fig. 2, 2*), the hymenophore (*l.c* pl. 1), and the absence of clamp connections (l.c. *fig. 2, 1*) as drawn in Heim's original figures correctly depict the subject. A fungus of much the same type but smaller and thinner, is *P. capensis* (Sacc.) Sing. The long, fusoid spores of the latter may be attributed to a parasite rather than to a bolete. Type material is not available at present.

Section **Sulphurei**, sect. nov.

Stipite ad basin vix vel haud canaliculato. Ad sarmenta et ad truncos.

Characters of the section: see key and Latin diagnosis. The type species is *P. sulphureus* (Fr.) Sing. (*Boletus sulphureus* Fr.)

KEY TO THE SPECIES

A. Pileus dark brown to olive brown with a slight green shimmer; said to grow on wood of *Acacia* ..... *P. viperinus*
A. Pileus yellow; on pine, and coniferous sawdust ..... 1. *P. sulphureus*

Description of the Species Occurring in Florida

1. **Phlebopus sulphureus** (Fr.) Sing. comb. nov.

Boletus sulphureus Fr., Epicrisis, p. 413. 1838.
Boletus hemichrysus Berk. & Curt., Ann. Mag. Nat. Hist. II. **12**:429. 1853.
Boletus sphaerocephalus Barla, Champ. Nice, p. 72. 1859.
Versipellis sulfurea Quél., Enchir., p. 157. 1886.
Viscipellis sphaerocephala Quél., Enchir., p. 155. 1886.
Xerocomus sulfureus Quél., Flore Mycol., p. 419. 1888.
Ixocomus sphaerocephalus Quél., Flore Mycol., p. 415. 1888.
Boletus hemichrysus var. *mutabilis* Peck, Bull. N. Y. State Mus. **8**:104. 1889.
Suillus sulphureus Kuntze, Rev. Gen. Pl. **3**:536. 1898.
Ceriomyces hemichrysus Murr., Mycologia **1**:148. 1909.
Boletus sulphureus f. *sphaerocephalus* Konr. & Maubl., Icon. Sel. **6**:469. 1937.
?*Boletus sulphureus* f. *silvestris* Kallenbach, Ann. Mycol. **22**:410. 1924.
?*Boletus lignicola* Kallenbach, Pilze Mitteleur. **1**:57. 1929.
?*Xerocomus lignicola* Sing., Ann. Mycol. **40**:43. 1942.

Pileus almost "primulin yellow" when young, becoming "straw yellow," with the margin mostly "picric yellow" to "pale lemon yellow," faintly appressedly fibrillose-subvelutinous with velutinous margin but more or less glabrescent, slightly shining when properly dried, slightly viscid when wet but drying quickly, the outermost layer very soft and detersible when dried, and then the color "pinard yellow" at the margin, more "baryta yellow" with a tinge of "pale orange yellow" toward the center which in age becomes "antimony yellow," hemispheric, then pulvinate with umbo, or obtuse, with incurved, later lobed margin, 30-200 mm. broad. — *Hymenophore* yellow, initially arcuate-concave and adnate with a decurrent tooth or plainly decurrent; tubes up to 9 mm. long and of rather equal length from near the stipe to near the margin; pores about 3 per mm., their diameter individually very variable, from 0.5-0.75 mm. near the margin to up to 1 mm. near the stipe; spore print with a distinct olive shade. — *Stipe* as bright a yellow as the pileus, subglabrous or somewhat fibrillose when fresh, the fibrillosity appearing like pulverulence when dried, detersible, ventricose or with the basal portion tapering downwards, or in age tapering from the apex downwards, smooth but with the upper half often coarsely fibrillose-ribbed or venose, the apex often brown spotted in old specimens, solid, up to 100 x 35 mm.; mycelium bright yellow. — *Context* colored almost as the surface, bluing when injured, but the change is variable in promptness and intensity, absent in old and dry material; odor none; taste mild.

Spores 5.5-11 x 2.7-4.8μ, ovoid-ellipsoid to cylindric-oblong or cylindric-subclavate, rarely tilda-shaped, thin-walled, brownish melleous to melleous-pallid, the more elongate the paler; *basidia* 12-28 x 6.8-7.5μ, 4-spored, very few 2-spored (in the short-spored form only); *cystidia* 17-36 x 6-8.2μ, very numerous on the pores, hyaline to deep melleous, naked or incrusted, fusoid-ampullaceous or fusoid-mucronate, or plainly fusiform; *trama* subhyaline, to

yellowish, the mediostratum deeper melleous, denser than the lateral stratum, the outer hyphae of the mediostratum somewhat diverging as are the hyphae of the loosely arranged lateral stratum, the mediostratum comparatively thick for a boletoid species, and progressively thickening while maturing and then not distinguishable from a trama of the *Phylloporus*-type; *cuticular velvet* deep canary yellow when seen in a thick layer but single hyphae almost hyaline, thin-walled, smooth, cylindric, equal, 3.5-7μ in diameter; all hyphae without clamp connections.

Chemical reactions.—KOH on surface of pileus, brownish; on tubes and pores, deep castaneous; on context ochraceous brown. — NH_3 and NH_4OH on surface of pileus hardly reacting at all; on context provoking more bluing. — $FeSO_4$ on surfaces and on context negative. — H_2SO_4 on surface of pileus, very deep castaneous; on tubes and pores, orange-ochraceous; on context little reaction. — Formol little reaction.

Habitat.—On stumps of *Pinus palustris* (in Florida) and of other pines *e.g. P. strobus, P. silvestris, etc.*, and also (in Europe) on sawdust from conifers even in sheltered places, fruiting practically the whole year but a given mycelium fruiting only at long intervals, rather rare everywhere.

Distribution.—In North America (known only from the eastern states) south to Florida, and also in Europe. In Florida it has been observed only in the northern part.

Material studied.—FLORIDA, CLAY CO. Green Cove Springs, Nov. 1925, *W. A. Murrill* (*Boletus hemichrysus*) (FLAS, FH);[3] ALACHUA CO. Sugarfoot Hammock, June 1938, *Murrill* (*B. hemichrysus*) (FLAS);[4] Flatwood 1 mi. east of Kelley's Hammock, July 1943, *R. Singer, F 2421* (FH).[5] MASSACHUSETTS, Ellis, Sept. 1913, *E. B. Blackford* (FH).[6] NEW YORK, Menando, *Peck* (NYS). SOUTH CAROLINA, Santee Canal, July 1849, *Ravenel, 985* TYPE, (FH). ALABAMA, *Atkinson* (NYS). ENGLAND. A good colored picture of *Boletus sulphureus* Fr. by Massee (NY).

I am very doubtful whether or not the changing or unchanging character of the context or the relative length of the spores has any taxonomic significance. The bluing is not too strong, and may remain unnoticed. The collection from Green Cove Springs has elongate-cylindric as well as ellipsoid-ovoid spores in one single carpophore. The question as to whether or not *Boletus lignicola* Kallenbach is specifically, or maybe generically, different from *P. sulphureus* is much more difficult to answer, and has no immediate bearing on our Florida bolete. The bolete described by Corbière as *Boletus sphaerocephalus* from Cherbourg, France, is the same species as ours but as far as Barla's original *B. sphaerocephalus* goes, we can only assume that it is identical with Corbière's species. French authors will no doubt elucidate this situation later. As for the identity of *B. hemichrysus* and *B. sulphureus*, we can only state that the above description when compared with Fries' diagnosis and with more recent descriptions and figures (Neuhoff *apud* Kallenbach, Corbière, Massee) shows complete agreement.

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3 This is a form with mixed (ovoid and elongate in the same hymenium) spores.

4 This is the elongate-spored form.

5 The short-spored form.

6 This, as all the collections from outside of Florida known to me, belongs to the form with elongate spores; so does the type.

Extralimital Species

Phlebopus viperinus, spec. nov.

Pileo obscure brunneo vel olivaceo-brunneo, leniter viridi-tincto viscidulo, cuticula in vetustis saepe fracta, semigloboso, sein convexo, dein plano, levi, admarginem tenui, 100-200 mm lato; hyphis terminalibus cuticulae cylindraceis, apice rotundatis, tenui-tunicatis; hymenophoro sulphureo, plus minusve concavo, poris minutulis, tubulis breviusculis (3.5 mm. longis in siccis), decurrentibus; sporis ellipsoideis, brunneolis, levibus, guttula magna instructis, 5-6.5 x 3.5-4.2μ; stipite pileo concolori, substriatulo, haud sulcato, cylindraceo, farcto, 70-120 x 7-13 mm., evelato; carne cremoricolori, laesa caeruleascente; hyphis haud fibuligeris. Ad folia putrida et ligna et sarmenta sub *Acacia,* Junio-Septembri.

This species is called *Boletus badius* Fr. by Mendoza (Philippine Mushrooms, Phil. Journ. Sc. 65:91. 1938) and kabuteng ahas, meaning snake mushroom in Tagalog (Filipino dialect). It is illustrated in pl. 54, *fig. 1* by Mendoza, *l.c.,* and the type is at the Farlow Herbarium. It is remarkable that in the Philippines the mushroom is thought to be poisonous, exactly as *P. colossus* is thought to be poisonous on Madagascar. It also occurs in Hongkong, U. S. N. Pac. Expl. Exp. *C. Wright 212,* det. Singer, CO-TYPE (FH).

Species Imperfectly Known

BOLETUS OVALISPORUS Clel., Toadst. Mushr., 2:191. 1935.

This may well be a *Phlebopus* but it is necessary to learn more about the shape of the hymenophore, the structure of the trama and the presence or absence of clamp connections before a transfer of this Australian species can be proposed.

BOLETUS FRAGICOLOR Berk., Hook. Journ. Bot. 4:137. 1852.

The well executed colored figure in Hooker's unpublished sketch book of Himalayan fungi suggests either a *Phlebopus* of this section or a *Gyrodon.*

2(11). PULVEROBOLETUS Murr., Mycologia 1:9. 1909. *em.*

Characters of the genus: Pileus viscid when wet, dry when observed in dry weather, cuticle usually (where studied) consisting of a cutis, more rarely of a trichodermium, often covered with the slender appressed hyphae of a veil that has a bright yellow (rarely inclining to greenish or orange) color and a pulverulent consistency, or else it is hyaline and glutinous; if there is no veil, there are nevertheless traces of a veil (the viscosity or some pulverulence on the stipe); the stipe is either entirely smooth or sometimes reticulate, usually subcylindric or somewhat thickened at the base but not typically bulbous-ventricose as in *Boletus;* tubes not or scarcely arcuate and usually more or less depressed around the stipe, usually rather long, and the longest tubes in the middle between stipe and margin, often very bright golden yellow to orange as never found in *Boletus,* and this color often very persistent after drying, the pores small to large, the trama truly bilateral-divergent though the difference

between lateral stratum and mediostratum not always strongly expressed in ammoniacal medium because of the solubility of the pigment; clamp connections none; spores typically elongate and either fusoid or ellipsoid-fusiod to subcylindric; cystidia usually rather large with the upper portion broadly inflated, or rather thin and ampullaceous; spore print olivaceous brown, *e.g.* "Isabella color," "orange citrine," "medal bronze;" context bluing only if a veil is present. Habitat: With coniferous *and* frondose trees.

This genus is easily distinguished from *Suillus* by the characters of the veil or its remnants, and the absence of glandular dots on the surface of the stipe; if a species has none of these characters, the incrustation of the cystidia and the chemical characters in combination with the presence of exclusive conifer-mycorrhiza point to *Suillus* while non-incrusted cystidia, and less active reactions of the usual reagents, in combination with an association with frondose trees points to *Pulveroboletus*. Some species in both genera have bright colored tubes. The dull red to pink color of the hymenophore is characteristic for *Suillus* while a vivid golden yellow to scarlet orange is more characteristic for *Pulveroboletus*.

The distinction between *Pulveroboletus* and *Boletus* is somewhat less easily achieved. Here again, the veil, if such is present, or its remnants, will help safely distinguish these genera. In case that there is no veil whatever, it is the sum of characters indicated in the key that decides to which genus a species belongs. One species of *Pulveroboletus* may also be looked for in *Boletus*, in fact, *P. retipes*, does not show, in a majority of cases, the yellow pulverulence of the pileus, and the cuticle is somewhat intermediate between a cutis and a trichodermium. Care should be taken not to confuse the pulverulent yellow basal mycelium of some species of *Boletus*, or the hymenial structure of the margin of the pileus which is yellow in one species of *Boletus* (*B. subsolitarius*), with the velar rudiments or remnants of a veil as found in *Pulveroboletus*. In general, the stipe of the Pulveroboleti is more slender than that of the Boleti.

The viscid and pulverulent species of the ancient genus *Boletus* have been united, in this paper, under one generic name for one positive and one negative reason. The latter consisted in the fact that the viscid species of what Gilbert called *Xerocomus, i.e.* sect. *Auripori* Sing., were found to have a truly bilateral trama, not one of the *Phylloporus*-type which, however, is similar in pigmentation when material in ammoniumhydroxide is compared, especially if the carpophores examined are not quite young enough. Since this group, consequently, is not closely related with *Xerocomus*, and also not with *Boletus* because of their habit (the very character on the basis of which Gilbert combined them with *Xerocomus*), it was natural to look for affinities in a group that is equally *Xerocomus*-like in habit but *Boletus-like* in structure, i.e. *Pulveroboletus Ravenelii* and closely allied species. It is obvious that the veil, still well developed in *P. Ravenelii*, gradually disappears in the other species allied to it, only to be found again as a more or less conspicuous viscidity on the surfaces of the pileus and stipe. A very strong similarity in important characters leads further to a few species where the viscidity of the stipe and the yellow pulverulence are no more constant characters though they can be noted in some specimens. Thus, we arrive at a definition of the genus *Pulveroboletus*

which may not be quite satisfactory to those who in the first place want a clear-cut definition in the Friesian style. But, on the other hand, our delimitation of *Pulveroboletus* will bring together a number of actually related species that cannot be placed satisfactorily in other genera. I trust that the taxonomists accepting this emendation of the genus *Pulveroboletus* will find it very convenient and natural after a considerate trial.

KEY TO THE SECTIONS

A. Veil present, dry, sulphureus; context and tubes bluing or becoming green on injury or pressure — ..... Section *Flavovelati*
A. Veil none, or not as described above; context neither bluing nor greening under any circumstances.
B. Veil none; stipe not glutinous, nos viscid, nor markedly cartilaginous, and never hollow.
C. Stipe smooth ..... (see under "D")
C. Stipe strongly reticulate ..... Section *Reticulati*
B. Veil either present (glutinous), or absent, and then the stipe viscid to glutinous.
D. Glutinous veil present ..... Section *Glutinovelati*
D. Stipe glutinous or viscid in wet weather, but veil not developed.
E. Hymenophore bright yellow, or bright golden-olive yellow, remaining so in dried condition ..... Section *Auripori*
E. Hymenophore leather color to brownish ..... Section *Cartilaginei*

Section **Flavovelati,** sect. nov.

Velo subpulverulento, sulphureo vel sulphureo-viridello, haud glutinoso, distincto.

Characters of the section: see key and Latin diagnosis. Type species: *P. Ravenelii* (B. & C.) Murr.

Description of the Species Occurring in Florida

2. PULVEROBOLETUS RAVENELII (Berk. & Curt.) Murr.

Boletus Ravenelii Berk. & Curt., Ann. Mag. Nat. Hist. II. **12**:429. 1853.
Boletopsis icterinus Pat. & Baker, Journ. Straits Branch R. A. Soc. **78**:68.1918.
Suillus Ravenelii Kuntze, Rev. Gen. Pl. **3**(2):536. 1898.

Pileus testaceous or latericious more rufous brown in the center but covered (especially on the margin, and in dry weather completely) by a sulphur yellow to lemon yellow ("strontian yellow" according to Coker & Beers) pulverulent, dry veil, viscid or subviscid beneath on the cuticle proper, glabrous or subglabrous aside from the veil, subpulvinate, then convex to nearly plane, 25-100 mm. broad. — *Hymenophore* lemon yellow, becoming alutaceous or sordid olive brown when older, and usually a beautiful cinnamon in dried specimens, bluing when injured, adnate but depressed around the stipe, occasionally arcuate when very young but soon becoming at least flat or convex; tubes 3-7 mm. long; pores small to medium sized (0.5-1.0 mm. in diameter), round or somewhat elongate, not dentate; spore print between "tawny olive" and "Saccardo's umber" in older prints, fresh prints not seen, but probably more olivaceous. — *Stipe* concolorous with the pileus and covered with the same yellow pulverulence which near the apex forms annular belts in some specimens while in others it adheres to the margin of the pileus, dry, occasion-

ally becoming minutely brownish, pustulate, solid, cylindric or tapering downward, or ventricose in the middle, 30-100 (-145 according to Cokers & Beers) x 4-13 mm.; veil arachnoid-pulverulent, sulphur yellow to lemon yellow; mycelium whitish to yellow. — *Context* whitish to yellow in the pileus, yellowish, rarely whitish in the stipe, bluing slowly when wounded, in dry weather sometimes not bluing at all; taste slightly acid; odor none or peculiar "like hickory leaves" (Coker & Beers).

Spores 7.5-13.5 x 4-6μ, most frequently 10-11 x 5-5.3μ when quite mature, ovoid-ellipsoid, ellipsoid-oblong, or ellipsoid-cylindric, melleous, with suprahilar depression; *basidia* 25-32 x 11μ, 4-spored; cystidia 36-47 x 7-10.5μ, hyaline or brown, fusoid, or subclavate, with a short and thin mucro; *trama* soon becoming indistinctly bilateral as in *Xerocomus* but in still closed specimens very distinctly truly bilateral of the *Boletus*-type, the lateral stratum strongly divergent and hyaline, the mediostratum honey yellow, of parallel-subinterwoven hyphae which are much denser than in the lateral stratum; veil consisting of loosely interwoven, long, filamentous hyphae of 3.5-6.5μ in diameter, with thin hyaline walls, and hyaline cell-sap, the yellow color due to a sulphur yellow crystalline incrustation which is soluble in alkali; all hyphae without clamp connections.

Chemical reactions unknown.

Habitat.—On the earth or on rotten wood in frondose, mixed and coniferous woods, often in deep shade, fruiting from June till November.

Distribution.—From Maine to North Florida and Alabama, and from Hongkong to Singapore.

Material studied.—FLORIDA, GILCHRIST CO., Jennings Lake,, Sept. 1938, *Murrill* (FLAS). MAINE, Kittery Point, edge of swamp, Sept. 1893, *Thaxter* (FH). VERMONT, Brattleboro, *Frost*, (under a herbarium name, unpublished), later collections as *B. Ravenelli* (FH). NEW HAMPSHIRE, Chocorua, Aug. 1910. *W. G. Farlow* (FH); Aug. 1907 (FH); Intervale, Sept. 1901, *Thaxter* (FH). MASSACHUSETTS, Randolph, Aug. 1897, *H. Webster* (FH); Williamstown, Sept. 1901, *Farlow* (FH). CONNECTICUT, Norwich, Sept. 1888, *W. A. Setchell* (FH). GEORGIA, Tallulah Falls, Aug. 1901, *A. B. Seymour* (FH); Rock Mountain, Sept. 1901, *A. B. Seymour* (FH). SOUTH CAROLINA, Santee Canal, *Ravenel, 810*, TYPE (FH). ARKANSAS, Oct. 1865. *J. M. Peters, 17* (det. Curtis AUTH.) (FH). ALABAMA, *Earle* (comm. Murrill) (NY). HONGKONG, June 1854, *C. Wright, 209* (det. Berkeley, AUTH.) (FH). SINGAPORE, Botanic Garden, *Baker* (TYPE of *Boletopsis icterinus*) (FH).

Since fresh Floridan material of this species could not be studied, our description is based on extralimital collections. The occurrence of this species in Eastern Asia is another example of one species having two seemingly or actually discontinued areas, one in eastern Asia and another in eastern North America. The veil of *P. Ravenelii* is surprisingly analogous to that of *Russula pulverulenta*.

Species Imperfectly Known

BOLETUS SUBGLOBOSUS Clel. & Cheer, Trans. R. Soc. South Austr. 47:63. 1923.

Without having seen the types, I would not transfer this species to *Pulveroboletus* though, judging from the description, it appears to be closely related to *P. Ravenelii*. It was described from South Australia.

BOLETUS FLAVIPES Berk., Hook. Journ. Bot. 6:135. 1854.

Said to have a mealy stipe like *P. Ravenelii*, this Himalayan species needs further study.

Section **Reticulati**, sect. nov.

Pileo stipiteve saepe flavo- vel aurantiaco-pulverulento, sed pulverulentia inconstante velumque haud efformante; stipite haud viscoso, fortiter reticulato.

Characters of the section: see key, p. 7, and Latin diagnosis. The type species is *P. auriflammeus* (B. & C.) Sing. (*Boletus auriflammeus* Berk. & Curt.).

KEY TO THE SPECIES

A. Pores becoming deep orange ..... *P. auriflammeus*
A. Pores not becoming deep orange ..... 3. *P. retipes*

Description of the Species Occurring in Florida

3. **Pulveroboletus retipes** (Berk. & Curt.) Sing. comb. nov.

Boletus retipes Berk. & Curt., Grevillea **1**:36. 1872.
Boletus ornatipes Peck, Ann. Rep. N. Y. State Mus. **29**:67. 1878.
Suillus retipes Kuntze, Rev. Gen. Pl. **3**(2):536. 1898.
Suillus ornatipes Kuntze, Rev. Gen. Pl. **3**(2):536. 1898.
Ceriomyces retipes Murr., Mycologia **1**:151. 1909.

Pileus "cartridge buff," then deeper yellow, gradually approaching a tone near "light brownish olive" or "buffy brown," or bicolorous from the beginning, in dry condition "smoke gray" and "straw yellow," often with intermediate colors such as "yellow ocher," "Dresden brown," *etc.*, often with a dry yellow pulverulence or pruina, especially on the margin, this pulverulence being more often seen on southern than on northern specimens, and showing an "apricot yellow" color, the cuticle proper viscid when wet, pileus pulvinate, with or without a narrow sterile margin, 40-180 mm. broad. — *Hymenophore* "baryta yellow" to "pinnard yellow," the pores "aniline yellow," the tubes finally becoming "orange citrine," adnate or slightly depressed, pores staining "empire yellow" when injured, not closed at first, 0.3-1.0 mm. wide, in large specimens sometimes reaching 1.5 mm. in diameter, of irregular size and shape, tubes up to 12 mm. long, rarely longer; spore print "Isabella color," deeper and more rusty in thick, old prints. — *Stipe* with a strong and sometimes strongly raised (as in *Boletus Frostii*) network of "pinard yellow" color on "baryta yellow" ground, sometimes with the same superficial pulverulence that is observed on some caps, later becoming more sordid, solid, flexuous in many specimens, subequal or ventricose in the middle, more rarely tapering upward, 50-120 x 10-30 mm.; mycelium yellow, inconspicuous. — *Context* pale yellow, more deeply yellow when bruised (between "light cadmium" and "lemon chrome"), and eventually becoming "smoky gray," not bluing at any time; odor none; taste slightly to rather distinctly bitter.

Spores 9.8-13 x 3.7-4.8μ, subcylindric-subfusoid, or fusoid with attenuate upper half, melleous; *basidia* 26-30 x 8.8-11μ, 4-spored, rarely some 2-spored;

cystidia 33-45 x 5.5-7.5μ, moderately numerous, little projecting, hyaline to melleous, frequently incrusted at the apex; *trama* truly bilateral of the *Boletus*-type, with a denser, fulvous brown (from dried material in NH_4OH), not very broad mediostratum and a strongly contrasting, strongly divergent, loosely arranged, subhyaline lateral stratum; *cuticle* consisting of repent, (2) - 7 - 7.7 - (9)μ thick cinnamon-melleous hyphae with cylindric-fusoid or clavate, sometimes rather short terminal hyphae, and at places where the tomentum is well preserved, the hyphae ascendant and the terminal members characteristically fusoid with mucro or appendage and dermatocystidioid; in neither case are the preterminal hyphae or chains of hyphae modified in any way, all *hyphae* without clamp connections.

Chemical reactions.—KOH on surface of pileus beautifully yellow (about "strontian yellow"); on context solid gray. — NH_4OH on context negative where it had been stained yellow by autoxydation before; where not stained (freshly broken surface) deep yellow by action of the NH_4OH. — $FeSO_4$ negative.

Habitat.—In mixed frondose woods, especially under *Betula populifolia, Fagus grandifolia,* and various species of *Quercus,* gregarious in small, often cespitosely connate; fruiting from June till September.

Distribution.—From the Maritime Provinces in Canada south to North Florida and Alabama, and according to Murrill west to Wisconsin. In Florida rare.

Material studied.—FLORIDA, ALACHUA CO., Aligator Sink, *Murrill, F 15691* (FLAS). NEW HAMPSHIRE, Shelburne, *Farlow* (FH); Lower Bartlett *Thaxter* (FH); Pequaket on Piper Trail, Mt. Chocorua, *Linder & Singer* (FH). VERMONT, *Frost* (under a herbarium name, later changed to *B. retipes*); another specimen from Brattleboro, Vt., with the determination *B. ornatipes* Peck and a note saying "This we once supposed to be *B. retipes*. B. & C." (FH). MASSACHUSETTS, Stony Brook Reservation, *Linder* (FH); Canton, *Linder* (several collections), (FH); Harvard, *Singer* (FH); Wakefield, *Singer* (FH). NEW YORK, Six Mile Creek, *Kauffman* (FH); *C. H. Peck,* TYPE of *B. ornatipes* (NYS). NEW JERSEY, Ellis (under a herbarium name), (FH). VIRGINIA *Phifer,* AUTHENTIC specimen of *B. ornatipes* (NYS). NORTH CAROLINA, Hillsborough, *Curtis, 6414,* TYPE (FH); Highlands, *Alma Holland* (*Beers*) *& C. S. Mangum & W. C. Coker, 9730* (FH). TENNESSEE, Crow Hollow, *A. H. Smith, 9871* (FH); other Tennessee material at FLAS etc. ALABAMA, *C. F. Baker* (det. Singer), (NYS).

This species tends toward the genus Boletus because of the inconstant occurrence of the yellow pulverulence and the characters of the cuticle. It reminds one of *B. auripes* Peck in some peculiarities. Murrill has specimens under this name from two more points in Florida (Clay Co., and Gainesville), but the writer has seen no one in the season of 1943.

Extralimital Species

Pulveroboletus auriflammeus (B. & C.) Sing. comb. nov.

Boletus auriflammeus Berk. & Curt., Grevillea **1**:36. 1872.
Boletus laeticolor Berk. & Curt., *apud* Curt., Bot. N. Carol., p. 96. 1867 (*nom. nud.*).
Ceriomyces auriflammeus Murr., Mycologia **1**:147. 1909.

This striking species which is fairly common in most of our southeastern states, does not reach Florida in the south, or, at least, has never been collected

there. The trama of young specimens is very strongly truly bilateral with a hyaline, loosely arranged and strongly diverging lateral stratum, and a melleous, denser, axillar mediostratum. The cuticle is a modification of a cutis consisting of long, filamentous, interwoven hyphae which never form a palisade. As for the structure of the stipe see Yates, Univ. Calif. Publ. 6:248. 1916.

Section **Glutinovelati,** sect. nov.

Velo glutinoso.

Characters of the section obvious from the key, p. 7, and the above Latin characterization. Type species: *P. corrugatus* (Pat. & Baker) Sing. (*Boletopsis corrugata* Pat. & Baker).

Pulveroboletus corrugatus (Pat. & Baker) Sing. comb. nov.

Boletopsis corrugata Pat. & Baker, Journ. Straits Branch R. A. 78:68. 1918.

Young plants of the type (FH) show a persistent or evanescent annulus which is due to an entirely glutinous veil; the mycelium is white; the habit is much like that of *P. Curtisii.* The cuticle is formed by filamentous, 5.5-7μ thick repent hyphae but beset with pyramidal, fasciculate strands of hyphae which are connivent with their upper ends, distantly septate, deep melleous, rather loose, parallel, the terminal members not differentiated and merely rounded at their apices and 6.5-7.8μ thick; the pores are medium wide, the tubes rather long and convex beneath, depressed around the stipe; the spores have the color of these of *P. auriporus,* and are ellipsoid-fusoid with suprahilar depression, 9-13.7 x 4.8-5.8μ; the trama is truly bilateral in young specimens, the mediostratum with denser, subparallel-subinterwoven, melleous hyphae, the lateral stratum with subhyaline looser and distinctly divergent hyphae, septa more numerous in the mediostratum; all hyphae without clamp connections. This has been described from Singapore.

Section AURIPORI Sing. (ut sectio generis *Xerocomi*), Ann. Mycol. 40:43. 1942.

Poris aureis vel laetissime olivaceo-aureis et in statu sicco; velo nullo vel haud abundante, luteo-pulverulento, haud glutinoso; pileo aut stipite aut ambobus viscidis; elementis hymenophori frequenter succo luteo-citrino repletis (in solutione ammoniaca), cito diffundente.

Characters of the section: these are obvious from the key, p. 7, and the above Latin diagnosis. Type species: *P. auriporus* (Peck) Sing. (*Boletus auripes* Peck).

KEY TO THE SPECIES

A. All cystidia narrowly and elongately fusoid with the thickest portion around the middle and the apical third usually more or less ampullaceous; *either* spores small (8.2-11 x 3.5-5μ, rarely a few reaching 14 x 5.2μ), *or* veil (though moderately distinct and rather fugacious) always present in young, fresh material.
  B. Veil present on the stipe; spores large: (13.5) -14.8- 18.5 - (20.5) x 4.5-6.5μ; pileus viscid and glabrous; mycelium white ..... 4. *P. subacidus*

B. Veil absolutely none; spores smaller; pileus not or indistinctly viscid and then drying very fast, somewhat subflocculose-subtomentose when dry; mycelium yellowish ..... *P. caespitosus*

or if fusoid, rather short and with the thickest portion in the upper third; spores

A. Not all cystidia as described above, either many of them or all of them clavate, medium to large: (9.2-18.5 x 4-6.8μ); veil absolutely none.

C. European plant with the pileus mostly pinkish ("onion skin pink" to "Japan rose," darker places reaching "ocher red" or almost "Indian red," more rarely colored about "vinaceous rufous" or "vinaceous pink"); stipe dry or, more rarely, viscid ..... *P. gentilis*

C. American and Asiatic plant with the fresh pileus not pinkish as above; stipe mostly distinctly viscid unless the gluten has been washed off by rain.

D. Western plant with large pileus (60-90 mm.) and stout stipe (60-90 x 18 mm.); apex reticulate and beset with viscid granules ..... *P. flaviporus*

D. Eastern plant (a similar form also in China) with usually smaller pileus and slenderer stipe; apex often with decurrent lines but rarely reticulate, without viscid granules though sometimes faintly yellowish flocculose ..... 5. *P. auriporus*

Description of the Species Occurring in Florida

4. Pulveroboletus subacidus (Murr.) Sing. comb. nov.

Ceriomyces subacidus Murr. Mim. Contr. Herb. Univ. Fla. Agr. Exp. Sta., Florida Boletes, p. 3. 1942. *nomen nudum.*

Pileo alutaceo-carneo vel ferrugineo-rubido, glabro, viscido, convexo vel plano, 60-105 mm. lato; hymenophoro laete flavo, adnato vel depresso, convexo, poris usque ad 2 mm. amplis; sporis in cumulo aeneo-olivaceis, circa 14.8-18.5 x 4.5-6.5μ; cystidiis 34-50 x 8-13.7 μ, fusoideis vel ampullaceis; stipite albo vel pallide flavido, roseolo-zonato vel -striato apicem versus, plus minusve flavo-tincto vedi sparsi haud annuliformis gratia, sicco vel subviscidulo, levi, 50-65 x 12-18 mm.; mycelio albo; carne pilei flava, stipitis alba, immutabili, inodora, subacidula; hyphis non fibuligeris. Prope quercus in silvis siccioribus.

Pileus "pale cinnamon pink" with "buff pink" and "Japan rose" to "onion skin pink," more "pale cinnamon pink" toward the margin, at places "testaceous" to "cao brown," other caps "Hay's russett," partly "ferruginous" or "burnt sienna," and center often paler than this, viscid, glabrous, always scrobiculate or rugulose, at least on the margin, convex to flat, 60-105 mm. broad. — *Hymenophore* between "citrine" and "sulphine yellow" ("orange citrine" with more yellow pores when dried) becoming nearly "olive lake" when old, often surrounded by the white projecting sterile margin, adnate or depressed around the stipe, convex elsewhere; pores 0.5-2 mm. wide, darker and more sordid on pressure; spore print between "orange citrine" and "medal bronze." — *Stipe* white to pale yellow with "pale Congo pink" to "Congo pink" stripes or zone near apex, aside from this tinted yellow when fresh because of the veil, glabrous except for the veil, nearly or quite smooth, dry or very slightly viscid in damp weather, solid or almost so, tapering upward or subequal, 50-65 x 12-18 mm., apex 9-12 mm., base often acuminate; veil (thick layer) "lemon chrome" but forming no more than a sparse floccosity on the surface of the stipe, the floccosity being fugacious and mostly diluted in color because of the color of the stipe showing through, denser and more conspicuous at an almost annular zone or belt at the apex of the stipe, or below a consistently glabrous

zone of at least 5 mm. breadth, sheathing the lower portion of the stipe, or present at the apex as well as below, but often rather obsolete both above and below, and more like a superficial floccosity than an actual veil; mycelium white. — *Context* of pileus between "naphthalene yellow" and "barium yellow," or partly paler, of stipe white, both unchanging, somewhat concolorous with the pileus immediately below the cuticle of the pileus; odor none, or slight, agreeable; taste somewhat acid, especially in the pellicle.

Spores (13.5) -14.8- 18.5 - (20.5) x -4.5-6.5μ, well colored, brownish melleous, with thin to moderately thickened walls, subfusoid or ellipsoid-fusoid, either with out or with a suprahilar depression; *basidia* 22-23 x 10.5-13.7μ, 4-spored; *cystidia* on pores 34-50 x 8.2-13.7μ, hyaline, fusoid with the apex attenuate to an obtuse tip, more rarely more distinctly ampullaceous above; hyphae hyaline, forming a bilateral *trama;* veil of the stipe consisting of agglutinated, subparellel hyphae of 2.7-8.2μ diameter, smooth, thin walled, filamentous, not always equal, dense, hyaline; all *hyphae* without clamp connections.

Chemical reactions.—KOH on surface of pileus little reaction, viz. a dull "cinnamon buff"; on the tubes "Prout's brown," then "mummy brown"; on the context negative, or weakly reacting to a dull "cinnamon buff." — NH_4OH on surface of pileus "vinaceous gray," later becoming a dull "cinnamon buff"; on tubegs merely becoming darker and sordid; on context of pileus greenish, on context of stipe negative. — HCl on surface of pileus "orange cinnamon," same color obtained on tubes; on veil of stipe deeper yellow. — $FeSO_4$ on the context of the stipe little reaction. — Phenol on the context of the stipe little reaction.

Habitat.—On the earth and on trunks (*e.g. Sabal* spec.), near oaks (*e.g. Quercus virginiana*) in comparatively dry woods, solitary to subcespitose, fruiting from July to October. Rare.

Distribution.—Florida.

Material studied.—FLORIDA. PUTNAM CO., Lake Swan. August 1935, *W. A. Murrill* (FLAS); DADE CO., just outside Fairchild Tropical Garden near Miami, in a somewhat open stand of pines and oaks (no pines closer than 12 ft.), October 1942, *R. Singer*, TYPE (FH); ALACHUA CO., Payne's Prairie, *R. Singer, F 2952* (FH).

5. Pulveroboletus auriporus (Peck) Sing. comb. nov.

Boletus auriporus Peck, Rep. N. Y. State Cab. **23**:133. 1873.
Suillus auriporus Kuntze, Rev. Gen. Pl. **3**(2):595. 1898.
Ceriomyces auriporus Murrill, Mycologia **1**:147. 1909.
Xerocomus auriporus Sing., Rev. de Mycol. **5**:6. 1940.
Boletus viridiflavus Coker & Beers, Bol. N. Carol., p. 53. 1943.

Pileus "orange cinnamon," "Mikado brown," "hazel," "Kaiser brown," often marked with "pale pinkish cinnamon," often (in dry as well as in very wet weather) with an olive tinge over part of the pileus in living condition but usually assuming the greenish or olive tones in dried condition, the dried pileus "spruce Y" with some "chipmonk" and a shade of "chutney," margin more "hazel" (M. & P), or a mixture of "antique gold," "hazel," "cigarette," "Oak briar," reaching "Malay," "cowboy," occasionally near "Rembrandt" (M. & P.), the olive portions "banana," "brass," "rattan," "burnished gold," "samo-

var," "tinsel," "deep stone," "buckthorn brown," "gold," viscid to glutinous when fresh, shining and remaining shiny, or becoming subopaque in dried condition, glabrous or subglabrous, smooth, with even, slightly incurved, then more or less widely projecting sterile margin which is white beneath, pulvinate, somewhat expanding in age, 22-90 mm. broad. — *Hymenophore* "strontian yellow," "lemon yellow," or even richer and more brilliantly yellow, becoming more golden greenish in age, unchanging, scarcely changing its color in dried material, somewhat convex beneath, adnate but somewhat depressed or deeply depressed around the stipe in most specimens; tubes 8-20 mm. long, *i.e.* comparatively long; pores still brighter yellow than the tubes in dried condition, otherwise concolorous, irregular and some compound, 0.5-1.2 mm. wide, or 5 to 5. mm. radially, and 8 to 5 mm. transversely, of unequal level; spore print melleous-olive to brownish olive. — *Stipe* whitish and partly slightly tinged with cinnamon, in some specimens at length yellowish, the apex becoming nearly the color of the hymenophore, and the remainder pale yellow and still stained with pallid cinnamon, the base often deeper colored (like the pileus) but the very base again white, usually viscid to glutinous, the gluten drying out in very dry weather, and washed off in heavy lasting rains, more rarely only subviscid to practically dry in specimens with greenish or olive colors on the pileus, very rarely in others, glabrous or with a very faint floccosity (use lens) which is interrupted at places and usually light yellow, mostly solid until age, fusoid or tapering upward and with acuminate base, 25-78 x 5-15 - (25) mm.; veil absolutely none; mycelium white. — Context whitish but more or less concolorous with the cuticle in the upper part of the pileus, and eventually often yellow above the tubes and at the apex of the stipe, otherwise pure white in the stipe, evereywhere unchanging (but "bruised places becoming brick red" in the stipe according to Coker and Beers for *B. viridiflavus*); odor none; taste somewhat acid.

Spores 9.2-17.7 x 4-6.5 - (8.8) μ, most frequently 11.5-14.2 x 4.5-5μ, strikingly variable in shape and size in different collections as well as in a single preparation, pale golden melleous to deep brownish melleous, well colored when mature, subfusoid, to fusoid to elongate-ellipsoid with a slight or more often very sudden and distinct suprahilar depression, with thin or in old specimens very often somewhat (moderately) thickened walls; *basidia* 21-38 x (6) - 7.8-10.5μ, 4-spored; *cystidia* of two types, (a) 27-56 x (6.5) - 9.5-15.5μ, clavate, or clavate with a mucronate tip but not ampullaceous, often bright yellow because a minority of cystidia holds the lemon yellow fugacious pigment-solution in some cases longer than other hyamnial and tramal elements, (b) more fusoid, like these of *P. caespitosus;* the latter (b) type frequently absent, and mostly in the minority; if present, there may transitional forms between (a) and (b) be observed in some specimens; *trama* truly bilateral of the *Boletus*-type, the lateral stratum, loosely arranged and strongly bilateral and strongly divergent, the axillar mediostratum denser; the *pigment* of the trama unstable, bright lemon yellow, disappearing an ammonical solution in the course of a few seconds or minutes and being replaced by a pallid grayish cream coloring matter which is stable; the *pellicle* is a cutis consisting of interwoven, long-filamentous, irregularly arranged, cinnamon hyphae of 2.5-7.5 - (19) μ diameter, strongly reminiscent of the structure of *Leccinum rubro-*

punctum; some *dermatocystidia* present on the apex of the stipe; all *hyphae* without clamp connections.

Chemical characters not known but probably little different from those of *P. gentilis* where most reactions are not distinctive and weak.

Habitat.—On the earth on naked humus or sandy soil, rocks, etc., in northern woods under oaks and on shaded lawns, in the south in fragments of high hammock vegetation; solitary or in small groups, or rarely subcespitose, moderately frequent in the north, fruiting from May until October, probably usually accompanying *Quercus specc.*

Distribution.—From New England to North Florida, west to Michigan and Alabama; also in China.

Material studied.—FLORIDA, ALACHUA CO. In and around Gainesville, *Weber* (det. Murrill) *F 15934* ("*B. auriporus*?") (FLAS); *Murrill F 19319* (FLAS); *F 17974* (FLAS); *F 9870* (FLAS); *R. Singer F 2091* (FH); *F 2527* (FH); July 25, 1943 (no number) *G. Weber* (det. Murrill, as *Boletus flavimarginatus*, technically AUTHENTIC for *B. flavomarginatus* but mixed collection (FH); CLAY CO., Doctor's Inlet *Murrill, F 19297* (FLAS); PUTNAM CO., Lake Swan, *L. & A. S. Rhoads, F 18197,* (det. Murrill) (FLAS). VERMONT, Brattleboro, *Frost* (as *B. glutinipes* Frost, later changed to *B. auriporus*) (FH); also as *Boletus auri*[*s*]*porus* Peck (NYS, FH). MASSACHUSETTS, Newton, *Farlow* (FH). RHODE ISLAND, East Providence, Farlow (FH). NEW YORK, New Baltimore, *Peck* CO-TYPE (NYS). NORTH CAROLINA, Chapel Hill, *W. C. Coker, 10661,* AUTHENTIC material of *B. viridiflavus,* (FH). GEORGIA, Tallulah Falls, *A. B. Seymour* (det. Singer) (FH); Tannery Brook, *A. B. Seymour* (det. Snell) (FH); also specimens from Connecticut, Washington D. C., Maryland, Michigan, Alabama, etc. in less well preserved condition but probably correct. CHINA, Hunan Prov., Ma-Ling-Tung, Sinning Hsien, *T. L. Liu* ("brownish above, deep yellow beneath, under bamboo forest"), *496* (FH).

The type from North Elba is not preserved as far as I could ascertain. The New Baltimore type is externally not too convincing but with the microscopical characters and the description at hand, it is satisfactory, inasmuch so, if the fact is considered that Peck consistently determined all later collections in the sense in which this species is described here. *Boletus caespitosus* was correctly distinguished from *P. auriporus* by Peck himself though described rather poorly with the emphasis put on the cespitose way of growth which is of small importance. *Boletus innixus* Frost, thought, by some, to be a synonym of *P. auriporus,* is hardly this species. The authentic specimens preserved here would rather suggest a species close to *Boletus* (or whatever the final generic disposition of it may be) *Roxanae* Peck, or *Xerocomus Boudieri* Sing. *Boletus glutinipes* Frost has evidently never been published after Peck advised Frost that he had already described this species under the name of *B. auriporus. P. flaviporus* (Earle) Sing. which Kallenbach placed in his list of synonyms of *Boletus auriporus sensu* Kallenbach (=*P. gentilis*), seems to be different from *P. auriporus* as well as from *P. gentilis* (see p. 17). *Boletus viridiflavus* Coker & Beers, according to authentic material received from the University of North Carolina, cannot be anything but the greenish form or stage of *P. auriporus.* This becomes understandable when we consider the fact that *Boletus auriporus sensu* Coker & Beers is at least partially based on specimens belonging to *P. caespitosus.* I have for a long time tried to distinguish *B. viridiflavus* from the typical *P. auriporus,* or from small-spored forms of the latter, or from specimens with more glutinous stipe, or from specimens with less olive

colored hymenophore. But no two of these characters were consistently correlated, and all kinds of combinations and intergradations made the distinction of forms impossible. The colors are products of weather conditions and age, the spores vary in younger and older, smaller and larger, diseased and healthy carpophores, and the viscidity of the stipe does not show a constant correlation with the size of the spores or the color of the carpophores. I have not seen the change of the flesh to brick red, indicated by Coker and Beers, but I do not think that this alone will prove to be a sound basis for distinction between the two species. *Boletus flavimarginatus* Murr. of which, according to Murrill (Mycologia 36:122. 1944), *B. viridiflavus* is a synonym is only partly identical with *P. auriporus*. Nomenclatorially, Murrill's change of mind on his own species does not mean that his type specimen which is different from *P. auriporus* (including *B. viridiflavus*) can be discarded. In a recent authentic collection, determined *B. flavimarginatus* by Murrill, and now preserved at the Farlow Herbarium, we found two species, *Xerocomus illudens* ssp. *xanthomycelinus* Sing. and *P. auriporus*. The unimportant character of a brighter yellow ring in the hymenophore has misled Murrill to combine two species which have nothing to do with each other.

Extralimital Species

Pulveroboletus caespitosus (Peck) Sing. comb. nov.

Boletus caespitosus Peck, Bull. Torr. Bot. Cl. **27**:17. 1900.

This is generally considered to be a synonym of the preceding species though it is well distinguishable by several characers as pointed out in our key. It thus happens that *P. caespitosus* is sometimes determined as *Boletus auriporus* as, for example, by Coker & Beers. This also explains why, by these authors, *Boletus viridiflavus* (*P. auriporus*) is said to have larger spores than what is described as *Boletus auriporus*. Since so much confusion has been caused by the erroneous identification of *B. auriporus* and *B. caespitosus*, and no good description of *P. caespitosus* has been published thus far, we shall give a full description of it notwithstanding the fact that it does not occur (or has not been found) in Florida.

Pileus when young as well as in age about "Sudan brown," somewhat tomentose, not or not much viscid, smooth, sometimes slightly areolated, convex or becoming almost flat, 12-80 mm. broad. — *Hymenophore* "lemon chrome" and remaining so, or becoming still deeper golden to about "aniline yellow" when dried, adnate and slightly depressed around the stipe when mature; tubes 5-10 mm. long; pores inequal, small to medium (up to 1 mm. wide, rarely wider), concolorous; spore print "old gold." — *Stipe* concolorous with the pores above, gradually more brownish toward the base, brownish longitudinally striped, equal or slightly to strongly tapering upward but frequently the base again attenute, viscid to glutinose on the surface, somewhat furfuraceous at the apex in some specimens 20-65 x 5-15 mm.; mycelium yellow; veil none. — *Context* yellowish white or with a purplish tinge near the surface of the pileus, and pale brownish in the lower part of the stipe, everywhere unchanging on exposure; odor none; taste mild or slightly subacid.

Spores 9.3-10.8 x 3.7-4.5μ from print, otherwise 8.2-11-(14)) x 3.5-5

(5.2) μ, pale melleous to melleous, ellipsoid-oblong to subfusoid; *basidia* 20-31 x 7.5-10μ, 4-spored; *cystidia* 28-60-(80) x 6.8-12μ, hyaline, fusoid with the upper part ampullaceous or more rarely tapering to a blunted cone, the apex (if cylindric) about 3-5μ thick, numerous at the pores, or sometimes rather scattered in mature plants; *trama* truly bilateral of the *Boletus*-type, a yellow solution leaving the elements of the hymenium when they are put in ammoniacal medium, this solution being destroyed in a few seconds or minutes.

Habitat.—On the ground, in mixed woods, probably always near frondose trees, cespitose but also often singly, fruiting during wet weather in summer and fall.

Distribution.—From Virginia south to North Carolina.

Material studied.—VIRGINIA, TYPE (NYS); also at Richmond, *Linder & Smart* (det. Singer) (FH). NORTH CAROLINA, Highlands, *Coker* (*Boletus auriporus*), *13414* (FH).

Pulveroboletus gentilis (Quél.) Sing. comb. nov.

Boletus sanguineus var. *gentilis* Quél., Assoc. fr. avanc. sc. (1883):504. 1883.
Viscipellis sanguinea var. *gentilis* Quél., Enchir., p. 156. 1886.
Ixocomus sanguineus var. *gentilis Quél.*, Flore Mycol. p. 413. 1888.
Boletus gentilis Kallenbach, Adna **4/5**:18. 1925.
Xerocomus gentilis Sing., Rev. de Mycol. **5**:6. 1940.

A rather complete description of this species and a good colored plate have been published by Kallenbach *in* Pilze Mitteleuropas **1**:96, pl. 36, 1935 where it is called *Boletus auriporus* Peck. The American plant, however, differs in the characters outlined in the key, p. 12. Gilbert (Bolets, p. 137. 1931) proposed the name *Xerocomus cramesinus* (Secr.) Gilbert for the European species. but this as well as Gilbert's statement "*Boletus auriporus* Peck is close but different" was violently opposed by Kallenbach. Gilbert's statement on *B. auriporus* has meanwhile been verified by this writer. On the other hand, the identity of *B. cramesinus* Secr., Mycogr. Suisse, **3**:39. 1833 is somewhat doubtful and at least impossible to prove. Thus the name cannot be used. It may be argued that the European species is merely a geographic race of *P. auriporus sensu lato* Kallenbach. This may be so. Yet, it seems to me that it is too early to combine the American and the European species under a single specific name so long as the distribution of these is not known better than at present. It is particularly important to find out about the status of the Chinese form mentioned here under *P. auriporus*. Good dried material of *P. gentilis* is preserved in the Höhnel Herbarium, (FH) under the name "*Boletus gentilis.*" The trama has a very fugacious lemon yellow pigment which, in this young specimen, is not replaced by a more uniform and stable pigment; there is only one type of cystidia (type *a*) and the spores are the same as in *P. auriporus*.

Pulveroboletus flaviporus (Earle) Sing. comb. nov.

Boletus flaviporus Earle, Bull. N. Y. Bot. Garg. **3**:297. 1905.
Ceriomyces flaviporus Murr., Mycologia **1**:147. 1909.

This, in our opinion, is not identical with *P. auriporus* though it certainly appears to be very closely related. The dried pileus is like *Suillus luteus* in

color, and also corresponds in color to some forms of *S. auriporus*, without, however, a trace of green or olive in any of the numerous specimens distributed by Baker that I have seen. The same is true for the tubes which are between "light cadmium' and "aniline yellow" in well dried material. The carpophores are decidedly stouter than those of *P. auriporus* or *P. gentilis*. The stipe, at its apex, still shows the reticulation very clearly. The spores of the types are elongate-ellipsoid to more often fusoid with attenuate ends and suprahilar depression, with rather thick, well colored walls, 13-18.5 x 5.8-6.8μ, *i.e.* with a larger average than in most specimens of *P. auriporus* and *P. gentilis;* the cystidia are broad and voluminous, hyaline in NH_4OH, 30-50 x 10.5-15.5μ, the apex either broadly rounded or short-ampullaceous or tapering to a subacute cone, always broadest in the upper third; basidia about 32 x 10.5-14μ. These specimens were collected under oaks in Santa Clara Co., California, *C. F. Baker* (Pacific Slope Fungi, *131*).

Section **Cartilaginei,** sect. nov.

Velo nullo; hymenophoro haud persistenter aureo-luteo neque aurantiaco neque aureo-olivascente; stipite haud vel vix reticulato, raro subreticulato pro parte, plus minusve carnoso-cartilagineo, saepius cavo; carne plerumque aut constanter immutabili; fungi tropici vel zonam temperatam inhabitantes australiorem.

Characters of the section: see key p. 7, and the above Latin diagnosis. Type species: *P. Curtisii* (Berk.) Sing. (*Boletus Curtisii* Berk.). This and the other representatives of this section have not yet been found in Florida.

Pulveroboletus Curtisii (Berk.) Sing. comb. nov.

Boletus Curtisii Berk. *apud* Berk. & Curt., Ann. Mag. Nat. Hist. II. **12**:429. 1853.
Boletus inflexus Peck, Bull. Torr. Bot. Cl. **22**:207. 1895.
Boletus fistulosus Peck, Bull. Torr. Bot. Cl. **24**:144. 1897.
Suillus Curtisii Kuntze, Rev. Gen. Pl. **3**(2):535. 1898.
Suillus inflexus Kuntze, Rev. Gen. Pl. **3**(2):535. 1898.
Ceriomyces Curtisii Murr., Mycologia **1**:150. 1909.
Boletus carolinensis Beardslee, Journ. Elisha Mitch. Scient. Soc. **31**:147. 1915.

The habit of this species is typical of *Pulveroboletus*, for it shows rather slender stipe, comparatively high, strongly convex pileus and small to medium sized carpophores. The mycelium is whitish. The stipe is not only viscid but of cartilaginous consistency and becomes hollow (a character also observed in some specimens of *P. gentilis*). The spores are (10.5)-11.2-15-(19) x 4.3-6.5μ, mostly around 13 x 5μ, sometimes as short as 13 x 7μ, melleous to dull-golden-melleous, ellipsoid-oblong to subfusoid-ellipsoid, almost as variable in shape and size as in *P. auriporus*, the walls comparatively thick, suprahilar depression slight to distinct, mostly present; basidia 25-32 x 6-10.8μ, 4-spored; cystidia inside the tubes somewhat seta-like in appearance because of the deep ferruginous brown color either in their lower part or in all parts, or becoming so, fusoid, with ampullaceous upper third, some not ampullaceous and these often with one to two septa and a small appendage, also clavate, 43-86 x 6.5-11μ, mostly 57-70 x 70-8.7μ if not non-septate; cheilocystidia are and remain hyaline, fusoid-ampullaceous, or filamentous-capitate, or fusoid-capitate, or of

the type of the septate bodies that are found in the tubes, about 1.5-7μ thick if not septate, and originating in the trama; trama truly bilateral, of the *Boletus*-type with a very loose and pale lateral stratum and a colored mediostratum, but in the available material (which is rather close to fully mature), the mediostratum much broader than the lateral stratum. The cuticle consists of the same kind of hyphae as in *P. auriporus,* but these hyphae are hyaline and melleous only in thick layers (a cutis with gelatinous enclosures); surface of the stipe very similar to that of the pileus but forming a very thin layer, beneath which there is the cartilaginous cortex consisting of suddenly very strictly parallel hyphae which do not gelatinize and soon become thick-walled, long, filamentous, pale melleous, some with a brownish-ochraceous pigment; all hyphae without clamp connections. This species is found in pine woods in Pennsylvania, Virginia, the Carolinas, Kentucky and Alabama, and may eventually be discovered in adjacent regions, possibly even in North Florida.

Boletus inflexus Peck is certainly the same. I have examined the type (NYS). *B. fistulosus* Peck (NYS) does not differ from the type of *B. Curtisii* (FH). *Boletus rubropunctus* Peck put in synonymy with *B. inflexus* Peck by Murrill is quite different and belongs in *Leccinum.*

Pulveroboletus rufobadius (Bres.) Sing. comb. nov.
Boletus rufobadius Bres., Bull. Soc. Myc. Fr. **6**:XXXVII. 1890.
Suillus rufobadius Kuntze, Gen. Pl. **3**(2):535. 1898.

This species was originally described from the Camerouns; we have (FH) material from Nengbe and from Ganta, Liberia, *G. W. Harley, 58, 77.* The pileus is golden brown to olive brown when fresh, 30-50 mm. broad, with the surface feeling like suede, convex, becoming flat; pores whitish brown, darker when mature, 15 per 10 mm., 5-6.5 mm. long; stipe concolorous with the pileus, brown on handling, solid or stuffed, darker furfuraceous, 60-100 x 5-6 mm.; context spongy, in the stipe rigid, pinkish tan color or light tan; spores 11-13 x 4.5-5.5μ (up to 15μ according to Bresadola); print the usual color of this group; basidia 30-36 x 8.5-9.5μ, 4-spored; cystidia 38-41 x 4-7.5μ, clavate-elongate to fusoid; cuticle of thin walled, hyaline, clampless interwoven 5-8μ broad hyphae surface of the stipe consisting of thin-walled, hyaline, filamentous, long, parallel, 1.5-4μ thick hyphae; these characters when added to the diagnosis given by Bresadola for the type seem to indicate that this species belongs to *Pulveroboletus* unless the tramal structure should unexpectedly be different from the truly bilateral type characterizing *Pulveroboletus.* The structure of the trama was not apparent in the material available. The external appearance is much the same as in the preceding species (see Bresadola, Iconographia **19**, pl. 937. 1931.

Pulveroboletus viscidulus (Pat. & Baker) Sing. comb. nov.
Boletus viscidulus Pat. & Baker, Journ. Straits Branch R. A. Soc. **78**:72. 1918.

This species, described from Singapore, has the same habit as the two preceding species. The stipe is said to be somewhat shallowly reticulate-fibrillose. I do not think that this makes it comparable with the species of the section *Reticulati.* We find the spores of the type specimens (FH) to be 7.7-9.5 x 4-

5.3μ, pale brownish melleous, ovoid-ellipoid with a small central oil-drop, about twice as long as broad with a slight suprahilar depression or with none at all; trama not investigable; cuticle not showing any particular structure in these specimens: all hyphae without clamp connections. *P. viscidulus* belongs in the neighborhood of the preceding species which it resembles a great deal. It differs from most species of *Pulveroboletus* in shorter spores.

Pulveroboletus phaeocephalus (Pat. & Bak.) Sing. comb. nov.

Boletus phaeocephalus Par. & Baker, Journ. Straits Branch R. A. Soc. **78**:70. 1918.

Described from Singapore, this belongs in *Pulveroboletus*. The data that can be gathered from the type specimens (FH), are conclusive enough to justify a transfer to this genus. The pileus is now a beautiful rusty brown color, the cuticle consisting of loosely arranged chains of equal, cylindric, clampless, thin-walled hyphae with cylindric broadly rounded terminal members of 14-38 x 5-7μ, forming a trichodermium; spores melleous, thin-walled, smooth, ellipsoid to cylindric, 9.7-14 x 5-5.5μ (sometimes as short as 10.5 x 5.5μ, or as elongate as 14 x 5μ); cystidia on pores clavate, *e.g.* 20 x 5μ; hyphae of the trama hyaline; general appearance as in other Pulveroboleti; pores rather small; mycelium white.

3(12). BOLETUS Dill. *ex.* Fr., Syst. Mycol. **1**:385. 1821, *sensu stricto* Gilbert, Bolets, p. 96, 1931, *non* S. F. Gray, Nat. Arr. Brit. Pl. **1**:640. 1821 (=*Polyporus sensu lato*), *nec Boletus sensu* Murr., Mycologia **1**:10. 1909, R. Maire, Publ. Instit. Botàn. Barcelona **3**:41. 1937 (=*Suillus sensu nostro*).

Tubiporus Paulet *ex Karst.*, Rev. Mycol. **3**:16. 1881. (Type *T. edulis*).
Dictyopus, Quél., Enchir., p. 159. 1886 (Lecto-type *D. edulis*).
Oedipus Bat., Bolets, p. 13. 1908 (Lecto-type *B. edulis*).
Boletus subgen. *Tubiporus* (Karst.) Konr. & Maubl., Icon. Sel. **6**:452. 1924-1937.
Suillellus Murr., Mycologia **1**:16. 1909 (Type *B. luridus* Schaeff.).
Ceriomyces Murr., Mycologia **1**:144. 1909. (Type *B. crassus* Battara).
Xerocomus sensu Reichert, Pal. Journ. Bot. **3**:292. 1940 (Type *B. impolitus* Fr.[7]).

Characters of the genus: Spore print olive or at least brown with an olive hue ("olive brown," "dark olive buff," "brownish olive," between "buffy olive" and "yellowish olive," "light brownish olive," between "citrine drab" and "deep olive"); context white or yellow, sometimes partly red, bluing, rare-

[7] Reichert's interpretation of the genus *Xerocomus* is contrary to the conception of all modern authors as well as of Quélet himself. It is a mere coincidence that *Boletus impolitus* is the first species mentioned. Reichert (*l.c.*) says: "But Singer (13) names as type species of the same genus the species *B. subtomentosus* which according to the rules of nomenclature cannot occupy this position because it was mentioned by Quélet only after *B. impolitus*." Which rules?, is all the comment I can make on this. As for the value of the genus *Xerocomus sensu* Reichert, it is impossible to find any character distinguishing it from *Boletus sensu stricto* unless the lack of reticulation on the stipe is seriously considered to be a generic character in the Boletaceae. The hesitancy of some authors regarding the generic position of *Boletus impolitus* was entirely due to the fact that the structure of the trama had not been used, then, for the distinction of boletaceous genera. This latter character has first been used by this author (1939) in order to separate *Xerocomus* from *Boletus*.

ly reddening or unchanging; stipe usually thick and fleshy, reticulate or flocculose punctate to flocculate-squamulose, rarely smooth and glabrous (use a lens), neither scabrous nor glandulose, dry and naked, in no stage and under no circumstances ever viscid or veiled; mycorrhiza with trees possibly not obligatory in some species, in others not very specialized as to the taxonomic position of the trees involved, or else with frondose trees; trama of the tube-walls truly bilateral, the lateral stratum broad, loosely arranged, strongly divergent, hyaline or nearly so, the mediostratum narrow, axillary arranged and denser than the lateral stratum, also more distinctly colored, the hyphae subparallel-subinterwoven, usually more frequently septate than those of the lateral stratum (septa about as close or nearly as close as those of the subhymenium); all hyphae constantly without clamp connections.

Murrill and R. Maire, applying the "first-species-rule," chose *Boletus luteus* L. *ex* Fr. as type species of *Boletus*. This rule, however, is not obligatory and should not be followed in this case since the first author who divided the Boletaceae (Suillidae, as he called them) into smaller genera, S. F. Gray, separated the genus *Suillus* with the type species *S. luteus* from the rest of the boletes, and Snell accepted this name. Thus, we have to come back to Gilbert's proposal to choose the type species of *Boletus* from those species not belonging to *Suillus* in the modern sense. This alternative lecto-type is *Boletus edulis* Bull. *ex* Fr. which we have accepted in 1936, and which is most satisfactory from a nomenclatorial as well as historical point of view.

KEY TO THE SECTIONS

A. Fungi with white and unchanging context (or at least not bluing except for very rare cases in which a slight bluing is observed near the tubes), mild taste, distinctly reticulate or quite smooth stipe; elongate spores, and a cuticle not consisting of an epithelium.

B. Tubes white, later yellowish, eventually mostly greenish, pores occasionally slightly brownish; cystidia not strongly colored ..... Sect. *Edules*

B. Tubes white, later grayish; cystidia strongly colored (melleous and brown) ..... Sect. *Grisei*

A. Fungi not combining all the above characters.

C. Stipe either reticulate or (rarely) entirely glabrous and smooth; pores never red; context mild or bitter though not containing poisonous matter; pileus never viscid.

D. Context whitish, or pale yellowish, usually more or less bitterish to strongly bitter, context, or at least tube-trama bluing when wounded ..... Sect. *Calopodes*

D. Context more or less yellow, mild, bluing or unchanging ..... Sect. *Appendiculati*

C. Stipe either reticulate and then pores red, or minutely to distinctly flocculose-punctate or flocculose-squamulose, never glabrous (except in very rare exceptional forms); context mild but sometimes containing poisonous matter; pileus viscid or dry.

E. Small to medium, rarely large species with the general appearance of *Xerocomus*, (i.e. stipe moderately broad and subequal to moderately thickened); pores in mature, medium sized specimens around 1 mm. wide, either distinctly open or daedaleoid-meandering when quite young, as seen under a lens ..... Sect. *Subpruinosi*

E. Medium to large, rarely small species with the habit of a typical *Boletus*, *i.e.* with comparatively thick or/and strongly ventricose stipe that is thickened either at the base, or at the apex, or in the middle; pores small, often stuffed when quite young, usually punctiform and not or little elongate, in medium sized, mature specimens rarely reaching an average diameter of 1 mm. ..... Sect. *Luridi*

(E*. If the pores are small (less than 1 mm. in diameter) and yellow, the stipe finely furfuraceous, and the cuticle with a distinct epithelium, see ..... Genus *Leccinum*, sect. *Luteoscabra*)

Section EDULES Fr., Epicr., p. 420. 1838.

Genus *Oedipus* subgen. *Homosarcus* Bat., Bolets, p. 13. 1908.

Characters of the section: these are obvious from the key, p. 21. Type species: *B. edulis* Bull. *ex* Fr.

KEY TO THE SPECIES

A. Stipe smooth, or at least not reticulate; pileus viscid ..... *B. Atkinsonianus*
A. Stipe more or less reticulate; pileus somewhat viscid, or dry.
  B. Apices of the terminal members of the cuticular hyphae-chains clavate and broadly rounded, not forming a definite palisade.
    C. Terminal members of the cuticular hyphae-chains erect but more or less connivent at least at places where the cuticle breaks; pileus "cinnamon brown" or "Prout's brown," "sepia," "mummy brown," "Dresden brown" or more olive than these, becoming paler and more yellowish at least near the margin, with a coarse, densely granular-subtomentose to fibrillose-squarrulose cuticle (like *Boletellus mirabilis*), fibrils of this covering often agglutinate because of a fugacious viscidity. Western species ..... *B. olivaceobrunneus*
    C. All cuticular hyphae strongly interwoven, the terminal claviculae often oblique but not connivent; pileus not deep brown (in Florida specimens), never tending to olive, glabrous or evenly subtomentose, often distinctly and persistently viscid ..... 7. *B. edulis*
      D. Pileus reddish brown or yellowish brown with more ochraceous margin; stipe tapering from a very thick base; in coniferous woods ..... (2) *B. edulis* ssp. *clavipes*
      D. Pileus purplish or uniformly deep red-brown; stipe usually ventricose, also often tapering upward ..... *B. edulis* (various subspecies).
  B. If the cuticular layer is completely developed, the epicutis consisting of an often disrupted but distinct trichodermium-palisade which forms a tomentum that is easily scratched off or washed off; terminal members of the palisade not or only exceptionally clavate ..... 6. *B. aereus*

Description of the Species Occurring in Florida

6. BOLETUS AEREUS Bull. *ex* Fr., Syst. Mycol. **1**:393. 1821, *pro parte* (*sensu* Bat.)

Plate 1, Fig. 2

Boletus aeneus Rostk. in Sturm, Deutschl. Flora, **3**:109. 1844.
Boletus vaccinus Fr., Epicr., p. 420. 1838 *sensu* Velenovsky, Cesk. H. p. 703. 1922.
Boletus reticulatus Boud., Bull. Soc. Mycol. Fr. **23**:321. 1876, *an* Schaeffer; *non* Hook. in Kunth, Syn. Pl. **1**:(9). 1822, *nec* Secr., Myc. Suis. **3**:39. 1833.
Dictyopus aereus Quél., Enchir., p. 159. 1886.
Boletus variipes Peck, Ann. Rep. N. Y. State Mus. **41**:76. 1888.
Boletus Atkinsoni Peck, Bull. N. Y. State Mus. **94**:20. 1905.
Boletus nobilis Peck, Bull. N. Y. State Mus. **150**:48. 1905.
Boletus edulis var. *reticulatus* Bat., Bolets, p. 14. 1908.
Boletus Gertrudiae Peck, Bull. N. Y. State Mus. **64**:50. 1911.
Tubiporus aereus Ricken, Vademecum, p. 206. 1918 (*descriptione exclusa*).
Boletus edulis ssp. *aereus* Konr. & Maubl., Icon. Sel. **6**:454. 1924-1937.
Boletus edulis ssp. *reticulatus* Konr. & Maubl., Icon. Sel. **6**:453. 1924-1937.
Tubiporus edulis ssp. *aereus* R. Maire, Publ. Instit. Botàn. **3**:45. 1935.
Tubiporus edulis ssp. *reticulata* R. Maire, Publ. Instit. Botàn. **3**:45. 1935.

Pileus "buckthorn brown" and often with a much deeper, "chukker" (M. & P.), shade at least at places, often purplish or vinaceous at places, sometimes producing the effect of "sayal brown," finely velutinous to tomentose when young, then glabrescent in many specimens and eventually usually cracking in large, irregular, areolate fragments, or minutely rivulose, never viscid, pulvinate, then less convex and eventually often flattened, 50-192 mm. broad. — *Hymenophore* white, at length greenish yellow, depressed around the stipe; tubes rather long, about 6-33 mm.; pores very small, initially punctiform and "stuffed," up to 0.5 mm. in diameter when mature, concolorous; spore print "olive." — *Stipe* "cinnamon buff" with a flush of "light pinkish cinnamon," or concolorous with the pileus but paler than "buckthorn" or "sayal brown," reticulate in the upper two thirds or more, more rarely only at the apex and even there occasionally so slightly that it may be overlooked (*B. vaccinus* Fr. ?), glabrous, solid, fleshy, tapering from a swollen, bulbous base or ventricose-fusoid with the thickest part near the middle, more rarely thick-cylindric, spongy and soft in the interior in old specimens, up to 95 x 40 mm. — *Context* white, sometimes somewhat brownish pink under the cuticle, unchanging in all parts or rarely very slightly and indistinctly becoming pinkish where cut; odor none in fresh material, but strongly cumarinous in dried material (more so than in *B. edulis*); taste mild.

Spores 11.5- 17 x 4.5-6μ, bright melleous to brownish melleous, usually broadest in the lower third and gradually tapering toward the apex, more rarely more exactly fusoid, with or without suprahilar depression or applanation; *basidia* 24-40 x 8.8-12μ, 4-spored; *cystidia* 24-42 x 7.5-14.3μ, ventricose-mucronate or fusoid-ampullaceous, few to fairly numerous on the pores, very scattered in the tubes, hyaline; *trama* truly bilateral, of the *Boletus*-type, not different from that of *B. edulis* (see next following species); *cuticle* of interwoven hyphae which are brown when seen in dense strands, superposed by a detersible and often interrupted but, in young undamaged specimens, very distinct trichodermium-palisade, the latter consisting of hyaline or slightly colored, erect hyphae-chains, the hyphae cylindric or subulate with rounded to rarely acute tip on the terimnal members which measure between 11-55μ in length and 5.8-10.2μ in diameter, the subseqeunt, lower member 13.5-20.5-(50) x 6.5-10.2μ; all *hyphae* without clamp connections.

Chemical reactions not studied.

Habitat.—Lawns and open woods, in Florida under *Quercus virginiana, Q. laurifolia, Q. laevis* and under other species of *Quercus* farther north and in Europe, possible also under other frondose trees, such as *Castanea, Betula, Fagus,* always on the ground, frequent in North Florida from May till October.

Distribution.—In New England and south to North Florida, west to Michigan and possibly to the Pacific Coast and Mexico, also in Europe (excepting northern Europe) and North Africa, and East Asia.

Material studied.—FLORIDA, ALACHUA CO., Gainesville, *R. Singer, F 1886* (FH); *F 2206* (FH); Newnan's Lake, *R. Singer F 2176/1* (FH); MASSACHUSETTS, Canton, *D. H. Linder* (det. W. H. Snell as *B. Atkinsonii aff.*), *1276* (FH). NEW YORK, Menands, TYPE of *B. varipes* Peck (NYS); Port Jefferson, types of *B. Atkinsoni* Peck and *B. nobilis* Peck, (NYS). CONNECTICUT, Old Lynn, TYPE of *B. Gertrudiae* Peck (NYS). Also several collections of fresh material from SPAIN, Catalonia etc.

This is the "cèpe d'été" of the French market (hence Paulet's name *B. aestivalis*, pre-Friesian, and misunderstood in later years), and, if colored dark enough, it becomes the "cèpe noir," the *B. aereus* Bull. *p.p.* Since Fries accepted Bulliard's species in 1821, distinguishing like Bulliard himself two forms or varieties (a) with snow white, and (b) with pale sulphureous flesh, we may well choose as the type the form (a) which is the *B. aereus* in the above description. In Fries' index, p. 515, we find, for the first time, the spelling *B. aeneus*, but it seems to me that the spelling in the main text should be accepted. Kallenbach gives a rather good picture of the dark form as found in Central Europe (cèpe noir), but the best illustration of our Florida plant which is more often ocher brown than blackish brown, may be found in Kawamura, Illustr. Japan. Fungi, pl. 140. 1930. This is the common species of the section *Edules* in Florida, and could be used for food to a great extent since it is easy to recognize and grows in the back yards of many homes in large numbers. It is as delicious an edible fungus as *B. edulis*.

Velenovsky calls this *B. vaccinus* but it is not certain that it is Fries's *B. vaccinus*. *B. reticulatus* in the sense of Boudier and many other French authors is the lighter colored form of this species, but this name cannot be used since it was validated by Boudier as late as 1876, 55 years after *B. aereus* had been validated by Fries. Besides, doubts have been expressed as to the identity of Schaeffer's plate which in a later edition is described as bluing. *B. Gertrudiae* Peck is described in a manner that would suggest a much more yellow species, but the specimens are indistinguishable from other pale forms of *B. aereus*. Peck did not see it in fresh condition, and the notes available may have been insufficient or misleading. In *Sturm's Flora*, Rostkovius called this *B. edulis*, and *B. edulis sensu* Secr. is also partly this species. It is likewise listed as *B. edulis* in Murrill's Florida Boletes (1942), and is considered to be a subspecies of *B. edulis* by Konrad & Maublanc and other French writers. However, once the anatomical differences of the cuticle are understood, it becomes perfectly clear that *B. edulis* and *B. aereus* are two different species. Peck subdivides his *B. variipes* which is the same as *B. aereus*, into three varieties, according to the characters of the reticulation of the stipe, but I am unable to state whether this is of any taxonomical importance at all. Lohwag and Peringer studied what they called *B. edulis* ssp. *reticulatus*, their indications on its anatomy, however, make it possible to think that they had either specimens of *B. aereus* that had lost their tricholermium-palisade, or *B. edulis* ssp. *euedulis* that had strongly cracked surface because of a sudden decrease in humidity.

7. BOLETUS EDULIS Bull. *ex* Fr., Syst. Mycol. **1**:392. 1821, *non* Rostkov.

Plate 1, Fig. 1

Leccinum edule S. F. Gray, Nat. Arr. Brit. Pl. **1**:647. 1821.
Boletus esculentus (Caesalp.) Persoon *ex* Persoon, Mycol. Eur. **2**:131. 1825.
Boletus limatulus Frost, Bull. Buff. Soc. Nat. Sci. **2**:104. 1874.
Tubiporus edulis Karst., Rev. Mycol. **3**:16. 1881.
Boletus filiae Gill., Tab. anal. Hym. p. 143. 1884.
Dictyopus edulis Quél., Enchir., p. 159. 1886.
Boletus bulbosus Schaeff. *ex* Cchroet. *in* Cohn, Krypt. Fl. Schles. **3**:499. 1888.
Gyrodon filiae Sacc. & Cub., Syll. Fung. **6**:53. 1888.
Suillus bulbosus Kuntze, Rev. Gen. Pl. **3**(2):535. 1898.

Ceriomyces crassus Batt. ex Murr., Mycologia **1**:149. 1909.
Boletus crassus (Batt. ex) Jacz., Opred. Grib. **1**:594. 1913.
?*Boletus frustulosus* Peck, Bull. Torr. Bot. Cl. **24**:146. 1897.
?*Ceriomyces frustulosus* Murr., Mycologia **1**:145. 1909.

Subspecies EUEDULIS R. Maire, Publ. Inst. Bot. **3**:44. 1935 *ut Tubiporus.*

This has not been observed in Florida but I have seen specimens from Oregon which probably belong here (comm. A. H. Smith, *19130, 20001,* MICH).

Subspecies CLAVIPES Peck, Rep. N. Y. State Mus. **51**:309. 1899 *ut* var.

Pileus "ochraceous tawny," or between "pecan brown" and "Kaiser brown," sometimes with a slight tinge of "cameo brown," also "hazel" or "auburn," the margin discolorous, paler and nearly always with a yellow tinge that may be more or less apparent according to age and weather ("yellow ocher," "mustard yellow," or even "ochraceous orange" at first), occasionally the pileus more yellow than brown, glabrous or subglabrous, slightly and not persistently viscid to distinctly viscid when wet, smooth, pulvinate, finally convex-applanate, 65-120 mm. — *Hymenophore* white, then near "yellow ocher" and eventually sordid green, the pores often becoming "chestnut brown," adnate but soon strongly depressed around the stipe; tubes long; pores small; spore print "olive brown." — *Stipe* pale brownish, pale reddish brown, smooth, except for a fine but distinct reticulation running down the stipe (from reticulate in the upper third to four-fifths approximately), glabrous, thick-cylindric and sometimes slightly to decidedly tapering upwards, never subfusoid-ventricose as in the European type, solid, fleshy, up to 130 x 35 mm. — *Context* white, sometimes slightly pinkish after a while in some parts, usually with a narrow bron?ish zone under the brownish portion of the cuticle; odor none, somewhat cumarinous when dried; taste mild.

Spores 13-17-(21) x 3.5-5.8μ, melleous, fusoid, with suprahilar depression; *basidia* 30-40 x 6.8-11μ, 4-spored; *cystidia* 36-48 x 4.5-12μ, variable in shape and size, the thickest portion either near the middle or in the upper third, with an apiculus or mucro at the tip, or ampullaceous above, usually more or less subfusoid to fusoid, the thickest and most conspicuous cystidia crowded on the pores; *trama* truly bilateral of the *Boletus*-type, sometimes entirely hyaline, sometimes with a slightly colored (pale melleous) mediostratum which is formed by parallel-subinterwoven axillar hyphae, and an always hyaline, much looser lateral stratum made up of strongly divergent hyphae; *cuticle* made up of thin hyphae which are not consistently erect and usually strongly interwoven in all layers of the cuticle, or at least combined in interwoven strands of hyphae, the terminal members of which are inflated at the apex to form distinct claviculae or capitate bodies which to the inexperienced may resemble a cellular structure; *trichodermium-palisade* not observed in any stage; all *hyphae* without clamp conections.

Chemical reactions.—KOH on surface of pileus darkening; on context "ochraceous tawny" or paler than this; on tubes brown. — NH_4OH on context pale yellowish. — $FeSO_4$ on context of stipe negative. — Methylparamidophenol negative everywhere.

Habitat.—In coniferous woods usually with some frondose trees (oaks, poplars, birches) scattered around, more rarely in pure stands of conifers, possibly also under birches alone; usually gregarious, sometimes solitary, on sandy, rocky, and humose ground, fruiting from May till October. Frequent in most of the eastern states but rare in Florida.

Distribution.—From Canada and New England south to North Florida and west at least to Utah.

Material studied.—FLORIDA, ALACHUA CO., near Newnan's Lake under *Pinus taeda* and *P. palustris*, the nearest oak 18 ft. away, May 30, 1943, *R. Singer, F 2716/III* (FH). NEW YORK, TYPE of *B. edulis* var. *clavipes* Peck (NYS); Newcomb, under *Abies balsamea* and *Picea rubra*, with some *Populus tremuloides* intermixed, September 17, 1941, *R. Singer 254* (FH). MAINE, Bar Harbor, Oct. 1935, *E. E. Morse*, (FH). NEW HAMPSHIRE, Alton Bay, under *Pinus, Tsuga, Betula*, July 24, 1944, *D. H. Linder* (det. Singer) (FH). MASSACHUSETTS, Arnold Arboretum, Oct. 1944, *R. Singer* with Boston Mycological Club (not preserved). UTAH, SALT LAKE CO., Big Cottonwood Canyon, under *Abies lasiocarpa* and *Picea Engelmannii*, in 9600 ft. elevation, August 3, 1936, *C. D. Darker*, (det. W. H. Snell), *6065* (FH).

This subspecies differs from the usual European type in its color and the shape of the stipe which, however, is not as good a character, in itself, as Peck may have thought. The claviculate hyphae-ends in the cuticle make it easy to distinguish this from *B. aereus* in Florida. The Florida collection is scanty and represents the only specimen I have seen thus far as far south as this. It grew in the neighborhood of *B. aereus* in spring but did not reappear, at least in the following summer, with the latter species. Peck (Boleti of the United States, p. 133) says that this "variety scarcely differs from var. *pachypus* R. & R. except in being reticulated to the base." Since our specimens were not all reticulate to the base, especially not the northern collections, it may seem to be logical to refer our plants to this variety of Richon & Roze. However, the pictures are different and do not look like the American subspecies. They lack the yellowish tinge on the margin.

B. frustulosus Peck is preserved at Albany. I think it is *B. edulis*, or possibly an old *B. aereus* that has lost its trichodermium-palisade, a pale and frustose (*i.e.* deeply rimose) form, the latter character being a strictly metereological one. The specimens collected by Earle and referred to this species by Murrill (NY as "type 1") may be an undescribed species, possibly of the Strobilomycetaceae, and certainly quite different from the actual type (NYS, part of it in NY).

B. edulis and its subspecies are excellent edible mushrooms. They were imported, up to the present war, to this country from Eastern Europe in dried as well as pickled form notwithstanding the fact that they are equally frequent in American woods.

Extralimital Forms and Species

Boletus edulis Bull. *ex* Fr. ssp. **separans** (Peck) Sing. comb. nov.

Boletus separans Peck, Bull. Buff. Soc. Nat. Sci. **1**:59. 1873.

The cuticle of young, well preserved specimens is sometimes somewhat tomentose but even then the tomentum consists not of a trichodermium-palisade but of hyphae that are interwoven and interlaced in all directions, and

the terminal hyphae reaching the surface of the pileus, are strongly thickened, clavate or capitate, exactly as in ssp. *clavipes* Peck. The main difference between this and the other subspecies of *B. edulis* consists in the color of the pileus and stipe which is purplish; also, the hymenophore tends to separate from the apex of the stipe, and Coker & Beers think that the spore print is somewhat less olive. I have seen no fresh spore prints of this subspecies, but if there should be a constant difference between the color of the prints in these forms, as there seems to be between *B. edulis* ssp. *clavipes* and *B. aereus,* this would serve as a reason for specific distinction. However, Coker & Beers also say that they find intergrading forms which would suggest that none of these characters is completely constant. *B. edulis* ssp. *separans* occurs from New York to North Carolina.

BOLETUS EDULIS Bull. *ex* Fr. ssp. PINICOLA Vitt., Funghi Mang., p. 168. 1835 (*ut* var.)

Boletus pinicola Vent., Mic. Agro Bresc., p. 39. 1863.
Dictyopus edulis var. *fuscoruber* Forqu. *apud* Quél., Assoc. fr. av. sc. (1889):511. 1889.
Boletus edulis var. *fuscoruber* Bat., Bolets, p. 14. 1908.
Tubiporus edulis ssp. *pinicola* R. Maire, Publ. Inst. Bot. **3**:45. 1935.

This subspecies of *B. edulis* has not been studied anatomically by the writer but if I understand Lohwag & Peringer's analysis correctly, they find the same swollen claviculate hyphae-ends of the interwoven trichodermium that I observed in ssp. *clavipes* and ssp. *separans*. This and the macroscopical characters seen by the writer in numerous collections of fresh material in Germany, Italy, Finland, and the U.S.S.R. seem to indicate that Vittadini's plant belongs to *B. edulis* as an autonomous subspecies, more precisely, the European conifer race. It has never been found in America, I believe.

BOLETUS OLIVACEOBRUNNEUS Zeller, Mycologia **27**:457. 1935.

This seems to be distinct from *B. edulis* as well as from *B. aereus*. Good specimens that were referred to this species by A. H. Smith after comparison with specimens so determined by Snell, and also by this writer, have a characteristic appearance that does not recall *B. edulis*. But it evidently belongs in this section, and is even closely related with *B. edulis* itself. For more detailed indications on this species see the key, p. 22.

BOLETUS ATKINSONIANUS (Murr.) Sacc. & Trott., Syll. **21**:236. 1912.

Ceriomyces Atkinsonianus Murr., N. Am. Flora **9**:144. 1910.

A specimen that obviously belongs to this species was collected by W. C. Coker and Alma Holland (Beers) at Highlands, N. C. The spores of this are fusoid with a slight supramilar depression, melleous, smooth, 12.6-13.6 x 4-4.8μ; basidia 4-spored, 20-31 x 8.2-10.2μ; cystidia very scattered even on the pores, hyaline, fusoid with the ventricose portion in the middle and the apex ampullaceous, up to 45 x 7μ; hyphae without clamp connections.

Macroscopically, this reminds one of *B. edulis* to which it is no doubt related, differing in "cartilaginous" and longitudinally striate instead of fleshy and reticulate stipe. It has been observed thus far only in North Carolina and Georgia, and may also occur in North Florida. Coker & Beers and Murrill agree that *B. obsonium* (Paul.) Fr. *sensu* Atk. *non al.* is the same species.

Phylogenetically, this species links the section *Edules* of the genus *Boletus* to the section *Cartilaginei* of *Pulveroboletus*, thus offering an analogous case with *B. retipes* which links the section *Appendiculati* of the genus *Boletus* to the section *Reticulati* of *Pulveroboletus*, and with *B. subsolitarius* which links the section *Subpruinosi* of the genus *Boletus* to the section *Auripori*, particularly *P. caespitosus*, of the genus *Pulveroboletus*. It seems that *Boletus*, as a whole, has derived from *Pulveroboletus*.

Species Imperfectly Known

GYROPORUS BIPORUS Murr., Lloydia 7:325. 1944.—Described from Florida, this would, schematically, key out in this section but probably does not belong here. From the tiny fragments I have, I cannot say where it really belongs, and whether or not it is distinct. It may belong in sect. *Macropori*, or to *Xerocomus*.

GYROPORUS ALBISULPHUREUS Murr., *l.c.*—Likewise described from Florida, this would key out here, provided the description of Murrill is correct. It is characterized by milk white pileus, and a yellow reticulum on the apex of the white stipe, sulphureous hymenophore, and occurrence in turkey oak woods.

CERIOMYCES PALLIDIFORMIS Murr., *l.c.* p. 324.—Another Florida species, described very recently. I have seen only tiny fragments of the last two species, and cannot say to which genus it belongs and whether or not it is an autonomous species. As a mere guess, one may think of forms of *B. aereus* Bull. *ex* Fr.

Section GRISEI (Sing.).

Xerocomus sect. *Grisei* Sing., Ann. Mycol. **40**:44. 1942.

Characters of the section obvious from the key, p. 21. The type species is *B. griseus* Frost. This section has conditionally been inserted in *Xerocomus* by the author but since the trama of the type specimens of the type species and of other collections of *B. griseus*, and also the trama of *B. fumosiceps*, a species with much more typically boletoid habit, has turned out to be truly bilateral, of the *Boletus-type*, it became necessary to transfer this section to *Boletus*.

KEY TO THE SPECIES

A. Reticulation of the stipe fine; stipe obconic and short; spores 3.2-4μ broad ..... 9. *B. fumosiceps*

B. Reticulaiton of the stipe rather strongly raised, the reticulating veins projecting almost as much as in *B. Frostii;* stipe not obconic and not short; spores 3.5-5.5μ broad ..... 8. *B. griseus*

Description of the Species Occurring in Florida

8. BOLETUS GRISEUS Frost *apud* Peck, Rep. N. Y. State Mus. **29**:45. 1878.

Suillus griseus Kuntze, Rev. Gen. Pl. **3**(2):535. 1898.
Ceriomyces griseus Murr., Mycologia **1**:145. 1909.
Xerocomus griseus Sing., Ann. Mycol. **40**:44. 1942.
?*Boletus flexuosipes* Peck, Bull. N. Y. State Mus. **8**:130. 1889.

Subspecies TYPICUS.

Pileus gray to brownish gray, not viscid, very finely subtomentose when young, glabrescent, with a narrowly projecting sterile margin, convex, 50-100 mm. broad, rarely broader. — *Hymenophore* white when young, becoming argillaceous when mature, staining brownish in injury, adnate or slightly depressed around the stipe; tubes 6-12 mm. long; pores about 0.5 mm. in diameter, or 10 per 5 mm. transversely, concolorous with the tubes; spore print about "dark olive buff" when thick and fresh. — *Stipe* pale gray to gray reticulate on grayish pallid or yellowish pallid ground, the reticulation strongly raised and always very distinctly visible without a lens, raised not quite as much as in *B. Frostii*, glabrous, dry, subequal, often flexuous, or at least curved at the mostly acuminate base, solid or stuffed, rarely becomnig somewhat hollow when old, 50-100 x 10-17 mm. — *Context* white, grayish pallid, or yellowish pallid at places, becoming sordid cinnamon pallid on prolonged exposure but practically unchanging when bruised; taste perfectly mild; odor fruity or none.

Spores 8-13.5 x 3.5-8μ, mostly 10.5-12.5 x 4-4.5μ, rather pale brownish melleous, cylindric or cylindric-fusoid; *basidia* 8.5μ broad; *cystidia* 31-58 x 6.3-10.3μ, strikingly colored brown (melleous brown to dark fuscous) by a resinous incrustation, ampullaceous to fusoid with the thickest part in the middle or in the upper third, and with a small apiculus or mucro, numerous near pores; *trama* truly bilateral of the *Boletus*-type, the lateral stratum very loose and distinctly divergent, hyaline, the mediostratum slightly colored, denser, consisting of axillary arranged, subparallel-subinterwoven hyphae; all *hyphae* without clamp connections.

Chemical reactions.—Not studied separately but hardly different from these of *B. griseus* ssp. *pini-caribaeae* (see there).

Habitat.—In oak woods on the ground, fruiting from June until October.

Distribution.—From New England to North Florida where it is rare.

Material studied.—There is only one collection in the Herbarium in Gainesville (FLAS) which I have not examined closely. This, as far as I know, is all that has ever been collected under the name of *B. griseus* in Florida. Extralimital collections: VERMONT, Brattleboro, *Frost*, TYPE (FH). MASSACHUSETTS, Canton, *D. H. Linder* (det. W. H. Snell with "?"), (FH). TENNESSEE, Cosby, *L. R. Hesler & A. J. Sharp*, (det. Hesler as *B. indecisus*), *9062* (FH).

Subspecies PINI-CARIBAEAE Sing. Mycologia **37**:797. 1945.

Pileus in color like *Leccinum scabrum*, *i.e.* about "Saccardo's umber," tomentose at places, the cuticle tending to become rimose forming small squamulae, non-viscid, convex, becoming flattish, about 120 mm. broad. — *Hymen-*

ophore gray, unchanging, not much ventricose beneath, adnate and sinuate around the stipe, with the attingent tube-walls stretched lamellosely, otherwise the pores rather equal in shape, varying from 0.7-1.5 mm. in diameter; spore print "dark olive buff." — *Stipe* white at the apex, otherwise a very pale drab, with a well elevated medium-wide network almost all over the stipe, tapering downward, solid and fleshy, about 100 x 25 mm. (but tapering to about 16 mm. at the base); mycelium white. — *Context* white, unchanging, soft at least in the pileus, mild, inodorous.

Spores.—12-15.3 x 4-5.5μ (characteristic individual measurements: 13 x 4.8μ, 13.7 x 4μ), very variable in size and shape, the shortest ones also often being the broadest ones, rather pale brownish melleous; *cystidia e.g.* 37.5 x 10.2μ, fusoid with the broadest part usually in the upper third, or clavate-apiculate, more rarely subampullaceous, brown from an incrustation or granular contents; *trama* as in the type subspecies; *clamp connections* none.

Chemical reactions.—KOH on surface of pileus becoming deeper colored; on context, sordid drab. — NH_3 on surface of pileus, almost slate gray. — NH_4OH on surface of pileus, somewhat more intensely colored. — $FeSO_4$ on context, pale greenish. — Methylparamidophenol slowly positive, rather distinctly lilac. — Formol, very pale salmon pink after a long exposure.

Habitat.—On shallow needle beds over lime rock in pure stands of *Pinus caribaea,* solitary. October and November.

Distribution.—Known only from South Florida.

Material studied.—FLORIDA, DADE CO., Coral Gables, Coral Way, *R. Singer F 1397* (FH).

Subspecies *pini-caribaeae* differs in the larger spores, the carpophores themselves being near the upper limit of the size of the type subspecies. The habitat is unusual for this section and very characteristic.

9. BOLETUS FUMOSICEPS (Murr.) Murr., Lloydia **6**:228. 1943.

Gyroporus fumosiceps Murr., Lloydia **6**:225. 1943.

Pileus "Isabella color," "buffy brown," later somewhat "hair brown" at places, finely but distinctly tomentose, smooth, non-viscid, convex, becoming flat, with entirely fertile margin, 80-130 mm. broad. — *Hymenophore* sordid white, then sordid gray, almost unchanging or becoming somewhat fuscous on injury, slightly to decidedly depressed around the stipe; tubes 10-11 mm. long; pores concolorous, small (6-10 to 5 mm. tranvsrsely); spores print olive brown. — *Stipe* sordid-pallid, whitish, reticulate all over or over its larger upper part, but the reticulation often incomplete and very fine and shallow, rather more so than in *B. edula,* glabrous, dry, strongly tapering downward, obconic, 30-60 x 25-50 mm, tapering to about 9 mm. at the base. — *Context* white, at some places (irregularly) light yellow, unchanging immediately after injury but becoming concolorous with the pileus after hours of exposure to the air; odor none, or faint and fruity; taste mild.

Spores 11-12.5 x 3.2-4μ, ellipsoid-fusoid, elongate, rather pale brownish-melleous; *basidia* 10.5μ broad, 4-spored; *cystidia* 23-53 x 6.3-10μ, fusoid, or fusoid with ampullaceous apex, characteristically deep melleous or fuscous, granulose, thin-walled, numerous; *trama* truly bilateral of the *Boletus*-type,

lateral stratum hyaline, loose, divergent, mediostratum subhyaline, axillar, of subparallel-interwoven hyphae; all *hyphae* without clamp connections.

Chemical reactions.—KOH on surface of pileus, more brownish; on context, melleous or ochraceos melleous (a strong distinct reaction).—NH_4OH on pileus, more brownish; on context reacting as with KOH but paler.—$FeSO_4$ on context, grayish olivaceous.

Habitat.—On the ground, under or near oaks, solitary, friuting in July.

Distribution.—North Florida.

Material studied.—FLORIDA, ALACHUA CO., TYPE (FLAS); also material from Gainesville, July 15, 1943, *W. A. Murrill* (det. Murrill & Sing.), AUTHENTIC (FLAS); Newnan's Lake, *R. Singer, F 2910* (FH).

The author was at first inclined to consider Murrill's species as a mere form or variety of *B. griseus*. However, the entirely different habit appears to be constantly correlated with the narrower spores and the much finer reticulation. It therefore deserves specific rank.

Section CALOPODES Fr., Epicr., p. 416. 1838 *sensu stricto.*

Sect. *Pachypodes* Konr. & Maubl., Icon. Sel. **6**:457. 1924-1937.

Characters of the section see key, p. 21. Type species: *Boletus calopus* Fr.

KEY TO THE SPECIES

A. Stipe yellow or red, strongly reticulate or slightly reticulate at apex.
  B. Pileus usually cracking into large frustulae, or rimulose; stipe reticulate almost its entire length. Western species, growing in coniferous woods ..... *B. frustosus*
  B. Not combining the above characters. Eastern American or European species.
    C. Pileus not pink.
      D. Stipe with a yellow network and without any red colors except for an occasional reddish or dull brownish red color ring-zone ..... *B. radicans*
      D. Stipe either with pallid network on red ground (at least over a certain zone in the middle of the stipe or deeper), *or* with red network on yellow ground.
        E. Stipe with red network on yellow ground ..... 11. *B. inedulis*
        E. Stipe with pallid network on red ground ..... *B. calopus*
    C. Pileus pink, eventually, and on drying, bleached ..... *B. Peckii*
A. Stipe white, not reticulate, or very faintly so ..... 10. *B. pallidus*

Description of the Species Occurring in Florida

10. BOLETUS PALLIDUS Frost, Bull. Buff. Soc. Nat. Sci. **2**:105. 1874.

Suillus pallidus Kuntze, Rev. Gen. Pl. **3**(2):536. 1898.
Ceriomyces pallidus Murr., Mycologia **1**:152. 1909.

Pileus "avellaneous," "cinnamon buff," with a hue of "chamois," "pale pinkish buff," "pinkish buff," "pale cinnamon buff," mixed with "pinkish buff," or "champaigne" (M. & P.) with "Cuban sand" (M. & P.), or "sea side, tea time" (M. & P.), "fallow" (M. & P.), "putty seed" (M. & P.), "sombrero" (M. & P.), sometimes with "avellaneous" warts, sometimes with "light vinaceous cinnamon" margin, usually slightly darker when wet, paler when dry, minutely tomentose when dry, or distinctly tomentose all the time, becoming rimulose, or rimulose-tessellate, non-viscid, pulvinate, becoming flat, up to 140 mm. broad.—*Hymenophore* whitish becoming pale greenish or

"citine drab," bluing when young and fresh on pressure or injury, adnate or more often depressed around the stipe; tubes 8-14 mm. long; pores concolorous, 0.3-0.7-(1) mm. wide, bluing when touched at least when young and fresh, becoming "olive buff" in old specimens; spore print between "Saccardo's olive" and "brownish olive" ("light brownish olive" in thin dry layer). — *Stipe* white or whitish, or more rarely partially concolorous with the pileus, indistinctly and very faintly reticulate, or with a crude and incomplete network at the very apex, or most frequently perfectly smooth to merely subrugulose, glabrous, subequal to subventricose, solid, 60-80 x 10-35 mm. — *Context* of the pileus white, sordid, or eventually with stripes of pale yellow or "light vinaceous fawn," becoming yellowish near the tubes after prolonged exposure in some specimens, interior of the stipe white but more or less marbled with "fawn color," at least near the base, unchanging after bruising, *i.e.* not bluing in any part; odor almost none; taste mild to bitterish.

Spores 8.5-12.5 x 3.5-5μ, fusoid to subclavate, with a slight suprahilar applanation, melleous; *basidia* 29-39 x 7-10μ, 4-spored; *cystidia* scarcely projecting, 6-9μ thick, fusoid-cylindric to fusoid-ampullaceous, hyaline or pale melleous; *trama* truly bilateral, of the *Boletus*-type, with very loosely arranged hyphae in the mediostratum, in dried material often secreting a bright yellow pigment-solution when examined in NH_4OH; *cuticle* of long, cylindric-filamentous, equal, thin (3.5-5μ in diameter), hyaline (NH_4OH) hyphae without clamp conections.

Chemical reactions.—KOH on surface of pileus little reaction; on context and on pores mostly somewhat brownish. — NH_3 and NH_4OH little reaction in all parts, but turning the context red or blue where previously treated with $FeSO_4$. — H_2SO_4 and HNO_3 on surface of pileus little raction. — $FeSO_4$ on context of pileus pale greenish with dirty ring; on context of stipe, caesious to pale bluish.

Habitat.—Under various species of oak in open dry woods, mixed pine and oak woods, mesophytic and high hammocks, solitary to very gregarious, and at places dominant, fruiting from May to November.

Distribution.—From New England to North Florida, and west to Michigan and Tennessee.

Material studied.—FLORIDA, ALACUHA CO., Gainesville, *R. Singer, F 2495 b* (FH); Newnan's Lake, *F 2921* (FH); *W. A. Murrill* (det. R. Singer), *F 2069* (FH); *Erdman West & W. A. Murrill, F 17714* (FLAS); Dayville, *R. Singer, F 2495* (FH); *F 2495 a* (FH); Kelley's Hammock, *W. A. Murrill, F 17962* (FLAS); COLUMBIA CO., Camp O'Leno, *W. A. Murrill, F. 21693* (FLAS); NW of High Spring, *W. A. Murrill, F 8515* (FLAS). VERMONT. Probably part of TYPE (FH). MASSACHUSETTS, Numerous collections (very common in this state), (FH). NORTH CAROLINA, Highlands, *W. C. Coker & Alma Holland, 9514* (FH). GEORGIA, Vicinity of Tallulah Falls, *A. B. Seymour* (det. Snell) (FH). MICHIGAN, Ann Arbor, A. H. Smith (FH). TENNESSEE, Elkmont, Great Smoky Mts. Nat. Park, *L. R. Hesler 11589* (FH).

This is somewhat intermediate between the *Edules* and this section because of the whitish stipe, the inconstant bitterness, and the whiter than usual context. However, it differs from the former section in bluing pores and tubes and the frequent presence of a bitter taste. I think this species is best placed with the *Calopodes*.

Ceriomyces subpallidus Murr., North Am. Fl. 9:145. 1910. is apparently a mixture of *B. edulis* and *B. pallidus*, and has to be rejected. I have seen the type (NY).

11. BOLETUS INEDULIS (Murr.) Murr., Mycologia 30:525. 1938.

Ceriomyces inedulis Murr., Mycologia **30**:523. 1938.

Pileus "sombrero," "maple," center more "mastic," "cracker," "Arizona," "prairie" (M. & P.), sometimes somewhat "buffy brown," also sometimes reaching "Saccardo's umber" or "tawny olive" in the middle, subtomentose or finely tomentose, more rarely with faint appressed tomentose squamulae, not viscid, the extreme margin at times narrowly "light cadmium," pulvinate, becoming more expanded, 50-100 mm. broad. — *Hymenophore* "pyrite yellow," or pl. 20, F 1 (M. & P.), becoming blue when touched, more or less depressed around the stipe; tubes about 5-10 mm. long when mature, rarely longer; pores concolorous with the tubes and likewise bluing, the bluish stains eventually becoming sordid brownish, very small to small; spore print brownish olive. — *Stipe* "lemon chrome" and "light cadmium," on the apex or three quarters down the stipe marked with a "pomegrenade purple" or "acajou red" or "clove pink" (the latter M. & P.) reticulation on yellow or rarely almost concolorous (red) ground in the middle and below and even often at the very apex, the base becoming somewhat olive, or otherwise discolored to sordid yellow or some kind of brown, very rarely indistinctly reticulated and then the reticulation partly replaced by minute floccose-furfuraceous scurf, solid, tapering downward from a slight ventricose thickening in the upper third of the stipe, or tapering from the very apex, more rarely equal but very thick, 50-110 x (11)-15-25 mm.; mycelium pale yellow. — *Context* yellow, light yellow, becoming blue on the slightest injury, the base somewhat discolored (olive, brown, similar to the color of the surface); taste bitter; odor not remarkable, weak.

Spores 10-15.3 x 3.5-5.3μ, ellipsoid-fusoid, in some carpophores some of the spores with attenuate apical half, with suprahilar depression, well colored, melleous; *basidia* 21-30 x 6.5-9μ, 4-spored; *cystidia* 34-47 x 6.3-7.5μ, fusoid or fusoid subampullaceous, numerous on pores; *trama* truly bilateral of the *Boletus*-type; *clamp connections* none.

Chemical reactions.—KOH on surface of pileus little reaction; on the context of the pileus yellowish brown. — NH_3 and NH_4OH negative everywhere. — Methylparamidophenol on context negative, on cuticle black.

Habitat.—Under various species of oak, solitary or gregarious on the ground, especially in well watered gardens, fruiting from May till September.

Distribution.—North Florida and South Carolina (see also observations).

Material studied.—FLORIDA, ALACHUA CO., TYPE and AUTHENTIC material (FLAS, FH); also numerous collections by Singer (*F 2035/1, F 2136, F 2498*, etc., all FH). SOUTH CAROLINA, Santee Canal, *Ravenel, 736* (*B. pachypus*) (FH).

The fine, red reticulation on the yellow stipe distinguishes this species from *B. calopus* Fr. as well as from *B. radicans* Pers. *sensu* Kallenbach. The latter is supposed to have little red on the stipe while in *B. calopus* the network is

more pallid than the deep red ground, and besides, it usually though not always is more projecting and striking. Schematically, *B. inedulis* Murr. would fit in the characterization of *B. albidus* ssp. *eupachypus* Konrad whatever that it, but I have not seen any form of either European species that would exactly match the Florida species.

Curtis, in his Herbarium (FH), considered this as *B. pachypus* Fr. I am almost sure that *B. subclavatosporus* Snell, Mycologia 28:474. 1936. from North Carolina is the same thing but a form with less conspicuous reticulation than the type of *B. inedulis*. I have seen such forms frequently myself. On the other hand, I do not overlook certain discrepancies in the descriptions such as the elongate cylindric stipe, the apparently more constantly claviculate spores, and the slightly aberrant colors of the pileus and the context. However, these colors are entirely within the range of variation possible or expected in *B. inedulis*, and so are the spores, and probably the stipe. Confirmation of this determination of *B. subclavatosporus* will be needed from fresh specimens from the type locality (Hot Springs). I have not examined the type. Murrill's name would, in case of identity with *B. subclavatosporus* fall into synonymy.

Extralimital Species and Species Incompletely Known

BOLETUS FRUSTOSUS Snell & Dick, Mycologia 33:33. 1941.

This has been more accurately described in Lloydia 7:56. 1944. However, the spore print is indicated as ochraceous brown. It may be assumed, under the circumstances, that this indication is based on preparations a year or more old. If the fresh spore print were of this color, *B. frustosus* could not be referred to this section. The non-frustose specimens I have from Idaho (Selway National Forest, *Rossbach*, det. Singer, FH) are hard to distinguish from good specimens of *B. radicans* in dried condition. *B. frustosus* is a western species.

BOLETUS RADICANS Pers. *ex* Fr. Syst. Myc. 1:390. 1821 *sensu* Kallenbach, Pilze Mitteleur. 1:88. 1934.

This has also been called *B. amarus, B. candicans, B. albidus, B. vitellinus,* etc., and one may be inclined, in view of the various and controversial interpretation of *B. radicans* in the European and American literature, to prefer one of the above names, but when the problem is studied from all the historic angles involved, it seems necessary to accept Kallenbach's emendation of Persoon's species. *B. radicans* has been collected by the writer in Maine, U. S. A., but has never been found in the southern states. It is uncommon but widely distributed in Europe.

BOLETUS FRAGRANS Vitt. *sensu* Slipp & Snell, Lloydia 7:53. 1944.

This western species is quite different from what is considered to be the rare Italian species described by Vittadini who says that the taste of his species is agreeable. Snell's species is closely related to *B. frustosus* and *B. radicans,* and also to *B. inedulis* and *B. subclavatosporus*. If autonomous, it will have to be renamed.

BOLETUS CALOPUS Fr., Syst. Mycol. 1:390. 1821.

A very common European species, by some authors called *Boletus pachypus* Fr. Compare also our observations on *Boletus inedulis* (Murr.) Murr. (no. 11).

BOLETUS SUBCLAVATOSPORUS Snell, Mycologia 28:474. 1936.

See observations on *B. inedulis* Murr.

BOLETUS PECKII Frost *apud* Peck, Rep. N. Y. State Mus. 29:45. 1878.

Ceriomyces Peckii Murr., Mycologia 1:151. 1909.
?*Boletus roseotinctus* Peck, Bull. Torr. Bot. Cl. 27:612. 1900.

This species reminds one of the group of *B. speciosus-B. regius* of the *Appendiculati*, and the group *B. miniatoolivaceus* of the Luridi but it certainly belongs here, and the similarity is mostly due to the color. We have seen specimens from various places from New England south to Georgia. Coker & Beers think that *B. roseotinctus* is the same; Snell thinks it is different. We have no definite opinion on the subject.

Section APPENDICULATI Konr. & Maubl., Icon. Sel. 6:458. 1924-1937.

Characters of the section: see key, p. 21. Type species: *Boletus appendiculatus* Schaeff. *ex* Fr.

KEY TO THE SPECIES

A. Context and tubes constantly unchanging, never turning blue in any part of the carpophore.
  B. Stipe 10-30 mm. thick, rather elongate; KOH on surface of pileus beautifully "strontian yellow" ..... (2. *Pulveroboletus retipes*)
  B. Stipe 28-45 mm. thick, rather bulbous at first; KOH on surface of pileus either negative, or yellow ocher ..... 7. *B. auripes*
A. Context and tubes or either of them bluing when fresh and young.
  C. Pileus vivid yellow or ocher brown to deep brown.
    D. Pileus vivid yellow. Floridan species (for a European species with this color see "F," *B. regius*) ..... (19. *B. flavissimus*)
    D. Pileus not yellow. European species (for a Florida species with this color see sect. *Luridi*, *B. luridellus*) ..... *B. appendiculatus*
  C. Pileus pink or pallid.
    E. Pileus pallid (grayish cream to whitish) ..... *B. pallescens*
    E. Pileus purplish pink or pinkish red to testaceous.
      F. Pileus "Corinthian red," or varying to "vinaceous russet" (according to Cokers & Beers), or "vinaceous tawny" to "Dahlia carmine" (according to Burt); context bluing strongly to a deep, bright blue; spores 2.8-4μ broad, mostly 3-3.5μ broad ..... *B. speciosus*
      F. Pileus much purer and brighter pink or purplish pink, rarely more yellow; context slightly bluing; spores broader than 3.5μ, rarely narrower than 4μ and up to 5μ broad ..... *B. regius*

Description of the Species Occurring in Florida

12. BOLETUS AURIPES Peck, Rep. N. Y. State Mus. 50:107. 1897.

Boletus crassipes Peck, Bull. Torr. Bot. Cl. 27:19. 1900 (=var. *typicus*).
Ceriomyces aureissimus Murr., Mycologia 30:522. 1938 (=var. *aureissimus*).
Boletus aureissimus var. *castaneus* Murr., Mycologia 30:522. 1938 (=var. *typicus*).

Var. TYPICUS.

Pileus "snuff brown," "Dresden brown," "raw sienna," center often discolored, reaching "clay color," sometimes discolored also near the margin, sometimes with an olivaceous hue, center glabrescent, dry, not shining except for the glabrate portions, pulvinate, eventually flattened or even somewhat depressed in the center, 77-108 mm. broad, sometimes even larger and occasionally reaching 200 mm. — *Hymenophore* "light cadmium" to "cadmium yellow," depressed around the stipe when mature; tubes medium long to long, usually about 12-22 mm. long; pores initially "stuffed" and "Naples yellow," later concolorous with the tubes and 0.5-0.8 mm. wide, unchanging; spore print between "buffy olive" and "yellowish olive" when quite fresh but soon becoming gradually less olive, *e.g.* between "Saccardo's umber" and "light brownish olive," adding a darker shade to the very old tubes. — *Stipe* "light cadmium" to "lemon yellow" with paler apex when young, then "light cadmium" with "cadmium yellow" or "lemon chrome" shades in the middle, and often with "massicot yellow" mixed in below, on the upper third or half distinctly concolorously reticulate, the reticulation raised somewhat less than in *Pulveroboletus retipes*, smooth and glabrous on the lower half, dry, very bulbous when young more elongate but still very thick or ventricose when old, solid, 80-100 x 28-45 mm. — *Context* "light cadmium" in pileus, concolorous with surface in stipe, completely unchanging under all circumstances in all parts; taste mild; odor very agreeable, of plum pudding dough, not very strong, retaining a strong fruity odor in dried material for at least a year if well prepared.

Spores (9.5)-12-13.7 x (3)-3.7-4.8μ, melleous, smooth, versiform, usually ellipsoid-cylindric with slightly narrowed apical half, also subfusoid, or tilda-shaped; *basidia* 27.5-34 x 9.8-11.7μ, 4-spored; *cystidia* 20-42 x 8.8-11μ, hyaline, versiform, usually ampullaceous or irregularly cylindric, rarely vesiculose, very scattered; *trama* of the *Boletus*-type; *cuticle* consisting of irregularly interwoven filamentous hyphae, the preterminal members filamentous and not parallel to each other, the terminal hyphae occasionally clavate or short-cylindric but mostly cylindric with rounded tip, some of the hyphae incrusted by fine granules, some walls somewhat thickened, clamps absent.

Chemical reactions.—KOH on surface of pileus, "yellow ocher"; otherwise little reaction.

Habitat.—In mixed and oak woods, and under oaks in gardens, mostly with *Quercus laurifolia* in Florida, on humus, sand and on grassy earth, gregarious, more rarely solitary, starting in May and fruiting through the summer.

Distribution.—From New York to Florida, in Florida rare and confined to the northern part of the state.

MATERIAL *studied.*—FLORIDA, ALACHUA CO., Gainesville, *W. A. Murrill, F 9278*, TYPE of *B. aureissimus* var. *castaneus* (FLAS); *R. Singer, F 2025 a* (FH); *G. Weber* (det. Singer), *F 2025* (FH). NEW YORK, TYPE of *B. auripes* (NYS). NORTH CAROLINA, Chapel Hill, *Alma Holland Beers, 11615* (FH); Highlands, *Helen Sherwin* (det. Coker), *13295 a* (FH).

The type form is unusual in Florida. The common bolete of this section in North Florida has been described by Murrill as *B. aureissimus* which is with-

out any question conspecific with *B. auripes*. Murrill himself did not really intend to separate these forms specifically as is proved by the fact that he described the type variety under the varietal name *B. aureissimus* var. *castaneus* Murr. This arrangement finds an obvious explanation in the fact that Murrill *still* worked under the assumption that *B. auripes* Peck was a mere synonym of *B. edulis*.

Var. AUREISSIMUS (Murr.) Sing., Mycologia **37**:797. 1945.

Ceriomyces aureissimus Murr., *l.c.*
Boletus aureissimus Murr., *l.c.*, p. 525.

Differing mainly in the characters of the surface of the pileus which is "chamois," "yellow ocher," "primuline yellow," "mustard yellow," "Naples yellow" or "cream color" with "amber yellow" portions, the extreme margin usually "light cadmium," often nearly "honey yellow" when young, more glabrescent than the type. Otherwise as the type variety.

Microscopical characters as in the type variety, only the whole cuticular layer characteristically light lemon color in NH_4OH with the pigment rather stable and unchanging.

Chemical reactions.—KOH in all parts (negative). — NH_3 and NH_4OH negative. — H_2SO_4 and HNO_3 negative. — Formol negative.

Habitat.—In high hammocks and gardens under *Quercus laurifolia, Q. virginiana,* and also in open turkey oak woods (*Q. laevis*), on humus, sandy soil, and grassy earth, usually in large groups, from May till October.

Material studied.—FLORIDA, ALACHUA CO., Gainesville, *W. A. Murrill,* TYPE of *B. aureissimus* (FLAS, FH); AUTHENTIC material of *B. aureissimus* (FH); *R. Singer, F 2505* (FH); *F 2037/1* (FH); *F 2078* (FH); Sugarfoot Hammock, *R. Singer, F 2573* (FH).

"Often collected here for food, sometimes by the peck, and much esteemed by the few who know it," says Murrill. The author has also eaten it and found it delicious.

Extralimital Species

BOLETUS APPENDICULATUS Schaeff. *ex* Fr., Epicr., p. 416. 1838.

A European species; for more detailed data see any modern European description.

BOLETUS PALLESCENS (Konrad) Sing., Ann. Mycol. **34**:424. 1937.

Boletus appendiculatus ssp. *pallescens* Konr., Bull. Soc. Myc. Fr. **45**:73. 1929.

This European species has been well illustrated by Konrad & Maublanc (as *B. appendiculatus* ssp. *pallescens*), and by Kallenbach (under the name of *B. aestivalis*). Fries' *B. aestivalis* is decidedly different from this. In 1931, Kallenbach started to add an alternative name, *B. Romellii* Kallenbach. He did this on two occasions but he gave his name second place after *B. aestivalis* Fr. which he still thought to be the same (why then the new name?), using the latter in some other articles that have appeared after 1931 without men-

tioning the alternative name which cannot, consequently, be used, according to the International Rules, art. 40.

BOLETUS SPECIOSUS Frost, Bull. Buff. Soc. Nat. Scienc. 2:101. 1874.

This species is moderately frequent from Maine to North Carolina, and authentic material as well as numerous other collections (FH) prove it to be different from the two preceding as well as the following species, mainly because of the narrower spores.

BOLETUS REGIUS Krombh., Naturg. Abb. Schw. 2:3. 1832.

Dictyopus appendiculatus var. *regius* Quél., Fl. Mycol., p. 424. 1888.

This is an autonomous European species, not a variety or subspecies of *B. appendiculatus* as some authors think. I have collected it in Austria, and think it is sufficiently distinguishable from *B. speciosus*.

Section SUBPRUINOSI Fr., Hymen. Europ., p. 504. 1874.

Characters of the section: see key, p. 21. Type species: *B. Barlae Fr.* (=*B. rubellus* Krombh.).

This section has formerly been incorporated in *Xerocomus sensu lato* by the Quéletian-Gilbertian schools but has very apparent affinities with species of the following section of *Boletus sensu str.* These affinities are not quite obvious when only European material is considered, but if American, more specifically Floridan, material is taken into consideration, this becomes quite evident. Some pairs with striking similarities, one from the *Subpruinosi* the other from the *Luridi*, are the following: *B. rubellus* Krombh. and *B. rubricitrinus* Murr.; *B. pulverulentus* Opat. and *B. oliveisporus* Murr.; *B. Weberi* Sing. and *B. Queletii* Schulz.

There are a few tropical species which key out here but which may eventually be found worthy of separation within another section. Some of them are striking because of the small size of the carpophores, others because of the yellow color of the mycelial tomentum. At present, we can see no reason why they should not be treated together with the northern species, with one possible exception, *viz.* the species with epithelium (group of *B. pernanus*); this latter species has been kept with the section *Subpruinosi* on a tentative basis.

KEY TO THE SPECIES

A. Cuticle with a distinct epithelium; diameter of the pileus 12-14 mm.; spores longer than twice as long as broad (Q larger than 2). Tropical species .....*B. pernanus*

A. Cuticle occasionally, especially in *B. rubellus*, with some intermingled spherocysts, or with a trichodermium-palisade the preterminal members of which are made up by very short to isodiametric hyphae; there is, however, no definite epithelium present (of the kind observed in *Leccinum albellum*); but if there is an epithelium, and the shape of the spores or the size of the pileus are not as indicated for *B. pernanus* above, see this alternative.

B. Spores comparatively very broad (Q=2, or smaller) without suprahilar depression; cuticle either a cutis, or an unorganized (not palisadiform) trichodermium (at least in the specimens available); mycelium yellow. East-Asiatic species (as for American species see genus *Xerocomus*, sect. *Pseudophyllopori*).
C. Pileus red ..... *P. Patouillardi*
C. Pileus not red.
D. Pileus olive umber, subsquamulose; context bluing; mycelium inconspicuous ..... *B. nanus*
D. Pileus alutaceous; context said to be unchanging; mycelium conspicuous, golden yellow ..... *B. aureomycelinus*
B. Spores narrow (Q larger than 2, or at least many spores with Q larger than 2 present in a print or in fully mature specimens); cuticle a trichodermium-palisade which, however, soon breaks down, and then the superficial layer made up of irregularly interwoven hyphae or strands of hyphae, not visibly organized, or the palisade at least partially discontinued and becoming fragmentary, usually entirely disappearing in fully mature specimens except in well sheltered caps; mycelium either white or yellow. Temperate species, and tropical species of the Western Hemisphere.
E. Pores red; pileus and stipe somewhat squamulose ..... 13. *B. Weberi*
E. Pores concolorous with the tubes and never red (unless after having been discolored by autoxydation); pileus and stipe not squamulose (the latter may be minutely furfuraceous, or flocculose-squamulose as commonly observed in many species of *Boletus*).
F. Pileus brownish or olive, chestnut brown or alutaceous.
G. Surface of pileus bluing with ammonia (see *Xerocomus*, sect. *Pseudophyllopori*).
G. Surface of pileus not bluing with ammonia.
H. Mycelium white or sordid, or if slightly yellowish, not conspicuous; marginal zone of the cuticle of the pileus not hymeniform.
I. Context unusually strongly and deeply bluing in less than one second after bruising provided the corpophore is not over mature and reasonably fresh; pores about "wax yellow." In frondose woods of the temperate zone of Europe and North America where it reaches North Florida in the south ..... 14. *B. pulverulentus*
I. Context slightly to moderately bluing; pores yellow but only exceptionally "wax yellow" (for species that do not change to blue at all, even when very fresh and young, see *Xerocomus*).
J. Pores "reed yellow," medium sized; spores 12.5-16.5 x 4.5-5.7μ. Temperate species in coniferous woods ..... (*Xerocomus badius*)
J. Pores not "reed yellow," wide; spores 8.8-13 x 4.5?5.5μ. Tropical American species (for species from other regions compare also genus *Xerocomus*) ..... 15. *B. granulosiceps*
H. Mycelium yellow, conspicuous; margin of the pileus covered by a hymenium ..... 16. *B. subsolitarius*
F. Pileus pink, vinaceous, carmine, or purplish, rarely olive (but then portions of the pileus or stipe red) ..... 17. *B. rubellus*

Description of the Species Occurring in Florida

13. BOLETUS WEBERI Sing. Mycologia 37:797. 1945.

Pileus "tennis" with some "alamo" (M. & P.), areolate-squamulose, dry, convex, 65 mm. broad. — *Hymenophore* "aureolin P" M. & P.), slightly convex beneath, depressed around the stipe, the radial tube-wall running down the apex of the stipe in fine lines, unchanged when wounded; tubes 6 mm. long; pores discolorous, "tapestry red" (M. & P.), unchanging on pressure, medium wide (0.5-1.0 mm. in diameter, 5-6 pores per 5 mm.); spore print olive brown. — *Stipe* "tapestry red" (M. & P.) at the apex, pl. 22, F 1 (M.

& P.) below, fibrillose-subpunctulate, squamulose below, dry, subequal in its upper two thirds, the lower third acuminate toward the base, without any network, solid, 53 x 17 mm. — *Context* light yellow, deeper yellow (about "pyrethrum yellow" M. & P.) in the base and toward the hymenophore, pale yellow where showing through the cracks of the surface of the pileus; odor very slight, agreeable.

Spores 9-15.3 x 4-5.5-(6.3) μ, melleous, thin-walled, from the base upwards attenuate or cylindric-subfusoid, often with an oblong oil-drop; *basidia* 44 x 10μ; *cystidia* 14-60 x 4-6.5μ, sometimes, especially on pores, melleous and somewhat thick-walled above, cylindric to cylindric-fusoid, numerous; *trama* truly bilateral of the *Boletus*-type, the thin mediostratum melleous, and denser than the definitely hyaline and distinctly though moderately divergent lateral stratum; all *hyphae* without clamp connections.

Chemical reactions.—NH_4OH on surface of pileus, negative; on context, blue. — H_2SO_4 where red becoming deeper red, and on surface of pileus also deeper colored. — $FeSO_4$ negative.

Habitat.—Under pines (*Pinus australis*) on the earth, solitary, fruiting in July.

Distribution.—Known only from the type locality.

Material studied.—FLORIDA, ALACHUA CO., Gainesville, Campus, *G. Weber, F 3036.* TYPE (FH).

This species is remarkable because it combines the characters of the red-pored *Luridi* with comparatively wide pores. It has no close relatives in *Xerocomus,* and the trama though with only moderately divergent lateral stratum and moderately loose arrangement of the hyphae, is still more typically boletoid than that of *X. badius*. The chemical reactions are remarkable for their comparative inactivity. It has been collected but once, but has features characteristic enough to be recognized immediately. We have, in the American literature, only one species with large, red pores, *B. parvus Peck* which differs in having reddish pileus and no squamulae.

14. BOLETUS PULVERULENTUS Opat., Wiegmann's Archiv Naturgesch. 2:27. 1836.

Boletus mutabilis Morg., Journ. Cincinnati Soc. Nat. Hist. **7**:6. 1881.
Uloporus Mougeotii Quél., Assoc. fr. avanc. sc. (1886):487. 1886.
Uloporus sistotrema var. *Mougeotii* Quél., Fl. Mycol., p. 411. 1888.
Suillus mutabilis Kuntze, Rev. Gen. Pl. **3**(2):536. 1898.
Boletus hortensis Smotlacha, Mon. česk. Hub Gribov., p. 40. 1910.
Tubiporus nigricans Hermann, Pilz- und Kräuterfr. **4**:124. 1921.
Boletus Rickenii Gramberg, Pilz- und Kräuterfr. **4**:226. 1921.
Boletus subtomentosus var. *nigricans* Hermann, Pilz- und Kräuterfr. **5**:175. 1922.
Xerocomus pulverulentus Gilbert, Bolets, p. 116. 1931.
Ceriomyces cyaneitinctus Murr., Lloydia **6**:225. 1943.
Boletus cyaneitinctus Murr., Lloydia **6**:228. 1943.

Pileus from between "bister" and "sepia" to "raw umber" but as deep as "mummy brown," margin either concolorous or rather "auburn" to "bister," a combination of colors that often gives the pileus a deep copper brown appearance, tomentose, especially on the disc, more rarely subglabrous but frequently

glabrescent and then slightly sticky in rainy weather, sometimes rivulose, rimulose, subsquamulose, the cracks subconcolorous but somewhat paler, not becoming reddish, pulvinate, then convex, with frequently flattened center or becoming irregular, 42-81 mm. broad, rarely larger (occasionally reaching 145 mm.). — *Hymenophore* about "wax yellow" and darkening to approximately "old gold" when quite mature, very strongly and rapidly bluing on injury, adnate or depressed around the stipe and then the radial walls of the tubes stretched forming a sublamellate ring around the stipe; tubes (5)-8-12-(20) mm. long; pores concolorous, immediately bluing where touched, up to medium wide and meandering when very young, then subangular, irregular in shape and size, more or less compound, 0.5-1.0 mm. in diameter, in average about 0.85 mm. wide or 5-6-(9) to 5 mm.; spore print olive. — *Stipe* a bright yellow at the apex, or pale cream color all over, often bluing on pressure, and eventually tending to reddish where it had been wounded, initially subvelutinous, then very minutely velutinous-flocculose-punctate, or with appressed fibrils with minute transverse fissures, more so below, frequently deep red or reddish brown below, finally a sordid or pale yellow brown in the middle, equal or subequal, more rarely ventricose at first, the basal portion very frequently acuminate, solid, 40-50 x 6-15-(27) mm., rarely up to 100 mm. long; mycelium white or yellowish white. — *Context* deep yellow, in the base usually but not constantly deep red, strongly and rapidly becoming deep blue in all parts when injured, the blue disappearing after a while as in all bluing boletes, and becoming sordid yellow, soft; taste mild; odor none.

Spores 11-14.7 x 4-6μ, fusoid, smooth, melleous, with or without suprahilar depression; *basidia* 28-40 x 8.8-9.3μ, 4-spored; *cystidia* 34.5-41-(65) x about 9μ, fusoid-ampullaceous, entirely incrusted by a resinous, melleous-fulvous incrustation (if less incrusted, they are melleous-granular); on pores, they are usually more numerous than in the tubes, and narrower, (5.2)-6.8-7.5μ broad, often subcylindric or with a short mucro, mostly hyaline; trama truly bilateral, of the *Boletus*-type, the broad mediostratum dense and deep melleous, the lateral stratum subhyaline, of broader and more loosely arranged, divergent hyphae; cuticular layer consisting of strands of parallel hyphae, these strands arising from different levels, reaching almost erect position, or more or less oblique, or even repent, the terminal members forming an often interrupted palisade of dermatocystidioid, clavate or sometimes fusoid, in ammonia more or less castaneous-fulvous (the pigment rapidly dissolving in the fluid) elements; all *hyphae* without clamp connections.

Chemical reactions.—KOH on surface of pileus deeper, darker; on context becoming reddish-ochraceous, then ochraceous brown. — NH_4OH on surface of pileus, little reaction; not bluing. — HNO_3 on surface of pileus, "Brazil red" to "oxblood red" (for other reactions see also Maire and Konrad, Schweizer Zeitschr. Pilzk. 5:4. 1927, and Kallenbach, Pilze Mitteleur. 1:14. 1927).

Habitat.—In high and mesophytic hammocks and in gardens, on lawns, farther north and in the mountains usually in mixed frondose woods or under shrubs, usually near Fagales (in Florida *Quercus laurifolia*, and possibly other species of oak, maybe also hickory) on grassy, mostly sandy or argillaceous soil, in small groups, fruiting from May till October.

Distribution.—Through Europe to the Caucasus Mts., and in North America from Ohio to Florida.

Material studied.—FLORIDA, ALACHUA Co., Kelley's Hammock, TYPE of *C. cyaneitinctus* (FLAS); Gainesville, *R. Singer, F 2711* (FH); Newnan's Lake, *R. Singer, F 2937* (FH). OHIO, under the name of *B. mutabilis* (AUTHENTIC?) (NYS). ITALY, Vahrn near Brixen (Bressanone), *F. v. Hoehnel*, and Jenbach (*id.*), *B 1146* (both as *B. radicans*) (FH). CAUCASUS MTS., Genswich (Genswitsch), Abkhazia, *R. Singer* (W); Khä, Swanetia, *R. Singer* (W.) Besides, many collections of fresh material in Europe (not preserved).

Our plant fits perfectly Opatowsky's description and colored picture published on pl. 1 of his paper, and also Kallenbach's picture, *l.c.*, pl. 6. The latter author has seen authentic material in Berlin. This makes *B. pulverulentus*, an up to very recently rather neglected though not infrequent species, one of the best documented species among the older ones. *B. mutabilis* Morg. belongs no doubt to this same species as has been suspected by Snell (Mycologia 26:348-349. 1934), at least that is what the specimens preserved at Albany are. This species is edible but not plentiful enough in Florida to be of much use.

15. BOLETUS GRANULOSICEPS Sing., Mycologia 37:797. 1945.

Plate 1, Fig. 4

Pileus "Dresden brown," "Prout's brown," "mummy brown," often partly or rarely entirely "clove brown," or more rarely an undescribable purplish-brown-black (not in Ridgway), finely velutinous-granular or more rarely evenly velvety all over or with the margin rimulose or subtomentose, dry, convex to flat, 30-65 mm. broad. — *Hymenophore* ochraceous-citrinous, much less golden yellow than in *P. auriporus* and less greenish and somewhat less pale than in *X. chrysenteron*, with a more ochraceous tinge than both of these, adnate to subdepressed; pores concolorous, bluing when pressed, wide. — *Stipe* with brown or sepia granulae or furfuraceous excrescences on paler ground, smooth or coarsely and indistinctly rugose-subreticulate or ribbed, equal or subequal, dry, solid, 30-50 x 6-8 mm.; mycelium sordid-pallid to whitish or white. — *Context* of the stipe brownish to pallid, bluing or unchanging, in the pileus pale yellow to orange-pallid, becoming slate blue to blue on exposure (slow reaction), deep yellow on very prolonged exposure (where eaten by animals); odor and taste not remarkable.

Spores (7.5)-8.8-13 x (3.5)-4 5-5.5 μ, most frequently 10-12 x 4.8-5.2 μ, variable in shape and size, especially when young, the mature spores usually ellipsoid-fusoid to fusoid, with or without suprahilar depression, smooth, well colored, melleous; *basidia* 27-41 x 9.5-11.5 μ, most frequently 33-35 x 10-11 μ, 4-spored; *cystidia* 23-56 x 6.8-11 μ, most frequently subulate because of a high septum, or fusoid with a conical but rounded apiculus or mucro or a subcylindric ampullaceous neck (not broad above as in *P. auriporus*), hyaline, smooth, or a few slightly roughened at the apex, very crowded at the pores, not so numerous in the tubes; *trama* of the hymenophore truly bilateral of the *Boletus*-type, the mediostratum light melleous, its hyphae subparallel-interwoven; the hyphae of the lateral stratum much more loosely arranged than in the mediostratum, and with fewer septa, the *hymenophore*, when placed into ammonia, bright yellow all over but the bright yellow pigment soon disappearing

(as in some Pulveroboleti); *cuticle* consisting of a brownish castaneous or castaneous-fulvous layer of erect hyphae which form a trichodermium-palisade whose terminal members assume the shape of dermatocystidia which are subulate, only few of them cylindric, 17-34 x (4)-5.5-12-(14) μ, the next-following (downwards) hyphae up to the preterminal hypha are somewhat contracted at the septa, sometimes as broad as long, 8.2-15 x 6.8-10.2 μ; *dermatocystidia* and dermatopseudoparaphyses none on the pileus; *basal tomentum* of long-filamentous, strictly cylindric hyphae, strands of which are parallel but interlaced with other strands or single separated hyphae, very similar to those of *B. subsolitarius*, 2.7-6.5-(8.3) μ in diameter; all *hyphae* without clamp connectios.

Chemical reactions not recorded.

Habitat.—Among ironwood trees (*Krugiodendron*), *Nectandra coriacea, Bursera simaruba*, etc., more than 38 ft. from the nearest oak tree (*Quercus virginiana*), along the roots and on the ground on lime soil in tropical hammock vegetation, solitary or in twos or threes, fruiting in September (and possibly all summer).

Distribution.—Tropical South Florida.

Material studied.—FLORIDA, DADE CO., Simpson Park, Miami, *R. Singer, F 696* (FH); *F 697* (FH) (CO-TYPES); Matheson Hammock, *R. Singer, F 760*, TYPE (FH).

This differs from *B. subsolitarius* which is the species most likely to be confused with *B. granulosiceps*, in fruiting earlier, having broader cystidia, more ochraceous tubes and pores, in the lack of the yellow tomentum at the base, in showing brown instead of yellowish granulae on the stipe, changing to blue if quite fresh and young, and in having a slightly different color of the pileus as well as of the stipe in dried and in fresh condition though these colors may occasionally come very close. It differs from *Pulveroboletus caespitosus* in never having viscid stipe and besides in many of the above cited differences between this and *B. subsolitarius*. According to its habit, this species would be considered as either *Xerocomus* or *Pulveroboletus* in the north but both belong in *Boletus* proper, together with several other tropical species of a similar general appearance. The total lack of veil and pulverulence, and also of gluten and viscidity, the structure of the cuticle and the bluing are entirely in favor of *Boletus sensu stricto*, and so is its natural affinity.

16. BOLETUS SUBSOLITARIUS Sing., Mycologia 37:798. 1945.

Plate 1, Fig. 5

Pileus with a pale yellow, tender, detersible tomentum or velvet on either granular or entire, brown ground (the brown ground perhaps sometimes a color mixture of the color of the cuticle proper and the yellowish covering on the margin) between "Sudan brown" and "raw sienna," with the margin between "Argus brown" and "mummy brown," or everywhere "cinnamon brown," "Mars brown," "hazel," later, when the external tomentum has almost completely disappeared becoming "Dresden brown" or "light brownish olive" on the margin, rarely on center, where it becomes "Brussels brown" in most instances partly "antique brown" or "amber brown," sometimes the yellowish tomentum macroscopically not evident, even in fresh specimens, and then the pileus merely brown tomentose, dry, smooth or somewhat rugulose, pulvinate,

soon becoming convex with more or less flattened or depressed center, 32-38 mm. broad. — *Hymenophore* "lemon chrome" and soon assuming a slight greenish shade, unchanging on pressure, adnate or slightly depressed around the stipe and usually the tube-walls which touch the stipe stretched and forming a lamellate ring around the stipe on which they run down a few millimeters; tubes up to 6 mm. long; pores concolorous, unchanging, medium wide to wide; spore print olive brown. — *Stipe* white to "massicot yellow," the apex usually concolorous with the pores or with such furfuraceous granulation, also the lower part of the stipe usually though not always with yellow furfurations or minute flocculose particles, base yellow ("picric yellow," "pale lemon yellow," "lemon yellow") tomentose from the mycelium which appears pale yellow in thin, rich yellow in thick layer, solid, strongly tapering downwards in all specimens, 33-38 x 11-12 mm. — *Context* whitish or "maize yellow" and "baryta yellow," unchanging on injury or becoming more yellow after prolonged exposure; odor none; taste mild.

Spores 8-13.5 x 4.7-5.5μ, usually 10-11 x 4.8-5.5μ, exceptionally some giant spores present (up to 20 x 6μ), very inconstant in size and shape, usually more or less oblong-ellipsoid and with suprahilar depression, smooth, melleous (well colored) to pale melleous, with moderately thin walls; *basidia* 27-38 x 8-10.5μ, 4-spored; *cystidia* 40-55 x 6.8-8.8μ, strictly fusoid, with narrowed but obtuse tip or neck, with normally thin wall above and often extremely thin wall below, rather numerous; *trama* of the hymenophore colored as in *Pulveroboletus auriporus, i.e.* bright yellow for a moment but then the pigment (in ammonia) moving out of the tissue and disappearing, being replaced by a more uniform and stable pale grayish melleous color, truly bilateral and of the *Boletus*-type, the mediostratum axillar, of subparallel-subinterwoven, multiseptate hyphae, the lateral stratum looser, entirely distinctly divergent and hyaline or becoming subhyaline but distinctly less colored than the mediostratum; *velutinous covering* of the margin of the pileus very peculiar, consisting of a hymenium of dermatopseudoparaphyses, dermatobasidia and some sort of hairs which, however, seem to be a mere modification of the dermatopseudoparaphyses; the latter 12-30 x 4.5-7.5μ; the dermatocystidia 23-31 x 10.5μ, scattered among the dermatopseudoparaphyses, in shape and size recalling the hymenial basidia, fertile; *cuticle* (except for the hymenial structure just described) consisting of a tissue of very interlaced hyphae, running in all directions, and the ones reaching the very surface are either repent or erect but do not form a palisade, the terminal members of these flexuous or crooked hyphae chains either cylindric and obtuse at the tip or broadly clavate and rounded, 4.8-9.8μ in diameter; *granulae* of the stipe originating with a bunch of parallel, longitudinally arranged hyphae which after a certain distance tend to be deflexed and curved outwards, terminating in a small palisade of dermatocystidia among which there are very few dermatopseudoparaphyses (*e.g.* 30 x 6μ) and perhaps dermatobasidia, the dermatocystidia-bearing hyphae hyaline, with crowded septa, smooth, thin-walled, parallel, 2.7-5-(6.8)μ; dermatocystidia hyaline, about 40 x 7.5μ, almost subulate but mostly narrower at the basal septum, often ampullaceous at apex; *mycelial tomentum* consisting of irregular strands of parallel hyphae with rather thin to very thin walls, their diameter 3-7μ their pigment yellow but very rapidly destroyed in ammonium

hydroxide and then the hyphae hyaline, always smooth; all *hyphae* without clamp connections.

Chemical reactions.—KOH on surface of pileus, black; on pores, brown; on context, brown. — NH_3 on pileus, lilaceous black, otherwise negative. — NH_4OH on pores, green; on context, green or negative.

Habitat.—In tropical hammock, under *Coccolobis laurifolia, Ficus aurea* etc. on shaded lime rock soil or along the roots, solitary or in small groups, not concrescent at the bases, in fall (September and October).

Distribution.—Tropical South Florida.

Material studied.—FLORIDA, DADE CO., Matheson Hammock, *R. Singer, F 894,* TYPE (FH); *F 1065, F 1233, F 1336* (CO-TYPES), (FH).

This species reminds one of *Pulveroboletus,* especially of *P. caespitosus.* However, it does not grow cespitosely and has a consistently dry stipe. The yellow pulverulence that can be observed at the base of the stipe, is of mycelial origin, not a veil, and the yellow external velvet of the margin of the pileus is of such fundamentally different structure from similar pulverulent coverings in *Pulveroboletus* (*P. Ravenelii* and *P. subacidus*) that we prefer to consider *B. subsolitarius* as an actual *Boletus* rather than a *Pulveroboletus.*

17. BOLETUS RUBELLUS Krombh., Naturgetr. Abb. Schw. **5**:12. 1836.

Boletus subtomentosus var. *b* Fr., Syst. Mycol. **1**:390. 1821.
Boletus versicolor Rostkov. *in* Sturm, Deutschl. Flora **3**:55. 1844, *non* Gray (1821).
Boletus sanguineus With. (*non* L.) *ex* Lev. *in* Paulet, Iconogr. Champ. 2nd ed., p. 97. 1855, *non* Secr. (1833).
Boletus rubripruinosus Barla, Champ. Nice, p. 64. 1859.
Boletus bicolor Peck, Rep. N. Y. State Mus. **24**:78. 1872 (=ssp. *bicolor*), *non* Massee (1909), *non* Raddi *ex* Sacc. (1925).
Boletus Barlae Fr., Hymen. Eur., p. 504. 1874.
Boletus rubeus Frost, Bull. Buff. Soc. Nat. Sc. **2**:102. 1874. (=ssp. *bicolor*).
Versipellis pruinata var. *Barlae* Quél. Enchir., p. 158. 1886.
Versipellis pruinata var. *versicolor* Quél., Enchir., p. 158. 1886.
Xerocomus chrysenteron var. *versicolor* Quél., Fl. Mycol., p. 418. 1888.
Xerocomus pruinatus Quél., Fl. Mycol., p. 420. 1888.
Xerocomus pruinatus var. *Barlae* Quél., Fl. Mycol., p. 420. 1888.
Boletus chrysenteron var. *versicolor* Mass., Brit. Fung. Flora, p. 264. 1892.
Xerocomus rubellus Quél., Assoc. fr. av. sc. (**1895**):620. 1895 (1896?).
Boletus fraternus Peck, Bull. Torr. Bot. Cl. **24**:145. 1897. (=ssp. *fraternus*).
Suillus bicolor Kuntze, Rev. Gen. Pl. **3**(2):535. 1898. (=ssp. *bicolor*).
Suillus Barlae Kuntze, *l.c.*
Suillus rubellus Kuntze, *l.c.*, p. 536.
Suillus versicolor Kuntze, *l.c.*
Suillus rubens Kuntze, *l.c.* (=ssp. *bicolor*).
Ceriomyces bicolor Murr., Mycologia **1**:152. 1909. (=ssp. *bicolor*).
Ceriomyces communis Murr., Mycologia **1**:155. 1909, *p.p.*
Boletus communis Coker & Beers, Bolet, N. Carol., p. 62. 1943.
Boletus parvulus Coker & Beers, Bol. N. Carol., p. 69. 1943, *non* Mass. (1909).
Boletus Cokeri House, Mycologia **35**:593. 1943.
?*Boletus pruinatus* Fr. & Hök., Bol., p. 9. 1835.
?*Boletus Preauxii* Mont., Phytogr. Canar., p. 75. 1840.
?*Boletus purpurascens* Rostkov. *in* Sturm, Deutschl. Fl. **3**:51. 1844.
?*Boletus armeniacus* Quél., Assoc. fr. av. sc. (**1884**):5. 1884.
?*Versipellis armeniaca* Quél., Enchir., p. 157. 1886.
?*Boletus bullatus* Britz., Hym. Südb. **4**:159. 1885.

?*Versipellis pruinata* var. *purpurascens* Quél., Enchir., p. 158. 1886.
?*Xerocomus armeniacus* Quél., Fl. Mycol., p. 419. 1888.
?*Suillus Preauxii* Kuntze, Rev. Gen. Pl. 3(2):536. 1898.
?*Suillus pruinatus* Kuntze, *l.c.*
?*Suillus purpurascens* Kuntze, *l.c.*
?*Suillus armeniacus* Kuntze, *l.c.*, p. 535.
?*Suillus bullatus* Kuntze, *l.c.*

This species is divided in several forms some of which we consider as subspecies. They are geographic races in some cases, in others mycoecotypes; some are merely remarkable forms, probably mutations. The subspecies known to the writer can be determined with the help of the following key.

A. European-African-Asiatic-Pacific *grex*: Mycelium whitish, sordid, or yellow; stipe yellow and often with red or carmine red tones, flocculose-squamulose at least in the middle; context bluing ..... ssp. *typicus*

A. Eastern American *greges* not combining *all* the above characters.

B. *Grex* characterized by yellow (light yellow, lemon yellow, bright yellow, sulphureus) mycelium.

C. Stipe appressedly fibrillose, not flocculose or scarcely so even when seen under a lens; context bluing.

D. South-temperate race, not occurring in the tropical zone: Pileus pinkish-brick red to carmine-purple, fading to yellow or brownish yellow; spores mostly 12.5-13.5μ long [(8.5)-10-14-(15)μ]; usually growing on lawns, in flower beds, moist places in and near frondose or mixed woods, mesophytic and low hammocks ..... ssp. *fraternus*

D. Tropical race: Pileus carmine-purple to olive, often the outer half sepia, becoming more deep purplish red when dried; spores short and broad (9.2-11 x 4.7-5.4μ); growing in tropical hammock; odor often disagreeable ..... ssp. *consobrinus*

C. Stipe flocculose-squamulose or almost furfuraceous, or velvety-scurfy; context only rarely bluing but the yellow surfaces, especially the pores not infrequently turning blue when touched; growing in the tropical hammock (if in low hammock compare carefully ssp. *consobrinus* f. *subdumetorum*) ..... ssp. *dumetorum*

B. *Grex* characterized by sordid white, sordid creamy pallid, occasionally salmoneous-ocher mycelium.

E. Races associated with frondose trees, not occurring in tropical Florida. scurfy, not deep red colored nor bright red; habit almost of *B. rubricitrinus* rather than of the slender forms of this species, *i.e.* with rather voluminous stipe ..... ssp. *caribaeus*

E. Race associated with frondose trees, not occurring in tropical Florida.

F. Prevalently southern race: Habit usually *Xerocomus*-like; stipe 28-64 x 5-12 mm.; pileus 24-52 mm. broad; spores 10.2-14.5 x 4-6μ, mostly 10.5-14 x 4.5-5.5μ ..... ssp. *bicoloroides*

F. Prevalently northern race: Habit usually *Boletus*-like; stipe 40-95 x 8-23 mm.; pileus 50-140 mm. broad; spores 9-12.2-(13.5) x 3.5-5μ, mostly about 11 x 4μ ..... ssp. *bicolor*

Subspecies TYPICUS

Boletus rubellus Krombh. *l.c.* and other combinations with this epithet.
Boletus versicolor Rostkov. *l.c.* and other combinations with this epithet.
Boletus sanguineus With. ex Lév. *in* Paul., *l.c.*
Boletus rubropruinosus Barla, *l.c.*
Boletus Barlae Fr., *l.c.*, and other combinations with this epithet.

As for this subspecies, we refer to Kallenbach, Pilze Mitteleur. 1:123, pl. 41; pl. 22, fig. 29; pl. 47, fig. 76. We cannot be sure that all these figures

belong here rather than to any of the other subspecies whose distribution and characters have not been studied in Europe, or to other forms not now known but distinguishable as subspecies within the European grex. However, judging from my own notes and from the description given by European mycologists, as well as by carefully comparing dried material from Europe, one arrives at the conclusion that none of the defined forms in Europe is actually identical with any of the forms belonging in the Eastern American grex. We have seen only one collection from the United States (*Richards, Morse, Landis et al.*, Mount Rainier, Wash., June 19, 1936, as *B. mirabilis*, FH) which we think is either identical with the larger forms of ssp. *typicus* (corresponding Kallenbach, *l.c.*, pl. 41, *fig. 17, 18, 23*), or represents an undescribed western race intermediate between this and ssp. *bicolor*. Since the floccosity of the stipe usually does not show well in dried material, the question has to wait for a solution until more data on the fresh fungus are available. We found the spores in these carpophores 11.8-15.7-(18.5) x 4.2-5.2μ, i.e., definitely larger than in *B. rubellus* ssp. *bicolor*, and very close to my European measurements.

If on the other hand, the ssp. *typicus* should consist of several (here neglected) forms or subspecies, it will probably not be difficult to find corresponding names for them among the synonyms and questionable synonyms indicated above for *B. rubellus* as a whole. We have no means of segregating them at present, and the problem of doing so (if necessary) remains to be solved by the European mycologists. Whatever future dispositions will be made, the type form must always be the form described and painted by Krombholz.

Some authors have accepted the name *B. sanguineus* for this species or rather for its ssp. *typicus*. This pre-Friesian binomial, a homonym even at the time of Withering, has to be disregarded, since the first post-Friesian author to take up this binomial, Secretan in 1833, used it in a different sense; in the sense of Withering, *B. sanguineus* was used by Léveillé many years later. The name *B. versicolor* is illegal for two reasons: It is a later homonym of *B. versicolor* L. *ex* S. F. Gray (*Coriolus versicolor*), and at the same time a synonym of *B. rubellus* Krombh. which was published eight years earlier. Fries' *B. pruinatus* is a *nomen dubium* because of the ambiguity of the description and the lack of any material to be checked upon. Not even a picture exists. It could have been accepted in the sense of Quélet (1886) who obviously interpreted it as *B. rubellus* but this latter species had been described meanwhile and its interpretation is unequivocal.

Bresadola was the first to link the American species (*B. bicolor*) with this and, as for specific identity, he was right.

Subspecies **fraternus** (Peck) Sing. comb. nov.
Plate 1, Fig. 3

Boletus fraternus Peck, *l.c.*
Boletus parvulus Coker & Beers, *l.c.*
Boletus Cokeri House, *l.c.*

Pileus "Pompein red" to "madder brown," "hydrangea red," "deep Corinthian red," "ocher red," "brick red," "terra cotta," rarely "coral red" to

"dragon's blood red," or even "jasper red" toward the margin, or "Hessian red" all over, soon cracking and showing the above colors on a yellow ground which is seen in numerous crevices, rarely the pileus remaining entire, sometimes the extreme margin pale red mixed with yellow without the cuticle cracking, often olive in dried condition, especially in young specimens, usually non-viscid but becoming slightly viscid occasionally in rainy weather, tomentose or tomentose-flocculose-subgranulose, or velutinous-punctulate, or fibrillose-subsquamulose-flocculose (usually very minutely so under a lens), pulvinate to convex or irregularly flattened with steeper margin, usually becoming applanate, 13-47 mm., rarely up to 95 mm. broad. — *Hymenophore* yellow, *e.g.* "pinard yellow" or "aniline yellow," then becoming more olive or greenish (*e.g.* with "citron green" or "aniline yellow" shades) adnate or somewhat depressed around the stipe, and then usually lamellately stretched in a narrow zone around the stipe on which the tube-walls often run down for a distance of 1-2 mm.; tubes 4-14 mm. long; pores comparatively rather wide, initially somewhat meandering, either equally wide or wider near the stipe (there 0.8-2.0 mm. wide if deeper secondary pores are disregarded), angular and more or less compound when mature, concolorous, bluing or greening when touched if quite fresh and not too old; spore print olive brown. — *Stipe* more or less concolorous with the pileus but with the yellow of the ground color showing to a varying degree between the appressed, innate red fibrils, sometimes the red color concentrated near the base, sometimes the apex yellow or the entire stipe almost without a trace of red, not flocculose-squamulose, not furfuraceous, only longitudinally appressedly fibrillose, dry, solid, equal or tapering toward the base which is often acuminate, (15)-30-70 x 2-11 mm.; mycelium forming a more or less distinct intensely yellow tomentum at the base, the mycelial strands in the substratum, however, are whitish yellow or yellowish white. — *Context* pale yellow to rich yellow in the pileus (*e.g* "baryta yellow"), deeper yellow in the stipe than in the pileus, on bruising slightly greening or bluing to strongly bluing at once; odor none; taste mild.

Spores (8.5)-10-14.5-(15) x 4-5.5-(6) μ, most frequently 12.5-13.5 x 4.5-5.5μ, brownish melleous, with thin or moderately thickened walls, smooth, ellipsoid-subfusoid with a slight, more rarely with a strong suprahilar depression; *basidia* 26-38 x 9.5-11μ, 4-spored, hyaline, or a few melleous; *cystidia* 41-68 x 6.7-12.5μ on pores, hyaline or melleous from a thin resinous incrustation, often partly incrusted, fusoid, frequently with ampullaceous apex with rounded tip, numerous, more scattered in the tubes; *trama* truly bilateral of the *Boletus*-type; cuticle formed by a palisade of dermatocystidium-like erect hairs (a trichodermium-palisade) which are occasionally rather broad and short, vesiculose, others elongate and capitate or ampullaceous, or subcylindric, sometimes with a septum in the middle, occasionally with isolated spherocysts intermingled in the trichodermium, especially in the layer formed by the basal cells of the palisade which as a rule are shorter than the terminal hyphae; though this structure may be mistaken for a cellular structure, there actually is no epithelium present; all *hyphae* without clamp connections.

Chemical reactions.—KOH usually reacting weakly, not causing strong color changes on the surface of the pileus. - NH_3 on surface of pileus, little reaction. - NH_4OH on surface of pileus in very fresh material that is not too

dry and not too watersoaked, usually provoking a brownish, fulvous, or olive stain around which a lilac or slate blue marginal ring develops.

Habitat.—On lawns, in flower beds, on moist places and banks in and near frondose woods and in low and mesophytic hammocks, on the earth, or sometimes growing along stones or roots or trunks, occasionally climbing up to 3 feet on standing trunks, solitary, gregarious, or even cespitose, fruiting from May till September or October.

Distribution.—Common in the southern states but reaching Massachusetts in the north, not reaching the tropical zone in the south, west to Missouri.

Material studied.—FLORIDA, ALACHUA Co., Gainesville, *R. Singer, F 2065* (FH); *F 2065 a* (FH); *F 2149* (FH); *F 2168 a* (FH); *F 2758* (FH); Sugarfoot Hammock, *R. Singer F 2669* (FH); HIGHLANDS Co., Highlands Hammock State Park, *R. Singer, F 648 B* (FH), *F 181* (FH). MASSACHUSETTS, Canton, July 23, 1927, *D. H. Linder* (FH). DISTRICT OF COLUMBIA, Washington, *S. E. Wilcox* (det. Peck as *B. sanguineus*), (NYS). NORTH CAROLINA, Pearson's Falls gorge, *W. C. Coker & party, 11928*, CO-TYPE of *B. parvulus* Coker & Beers (FH). ALABAMA, Auburn, L. M. Underwood, TYPE of *B. fraternus* Peck (NYS). MISSOURI, Valley Park, *D. H. Linder*, Aug. 29, 1928 (FH).

Forma **subdumetorum**, f.n.

Recedit stipite flavo, brunneo-punctato. In dumetis tropicis humidissimis.

This differs from the type only in having the character of the surfaces of the stipe exactly as ssp. *dumetorum* from which it differs in "madder brown" color of the rimose pileus and much stronger bluing of the context, and also in the habitat in grassy openings in the low hammock instead of the thicket of the tropical hammock. It is known only from the type locality, Highlands Hammock State Park, Highlands Co., Fla., *R. Singer*, Sept. 8, 1942, *F* 648 *A* (FH).

Coker & Beers have described a new species which they consider as closely related to *B. fraternus* Peck, *i.e B. rubellus* ssp. *fraternus* (Peck) Sing., calling it *B. subfraternus* Coker & Beers, Bol. N. Carol., p. 61 1943. The material kindly sent us by these authors is, in the writer's opinion related with *Boletellus turbinatus* (Snell) Sing. rather than with *Boletus rubellus* and its group. The spores are very characteristically mucronate at the apex, and differ in size from those of the known smooth-spored species of *Boletellus* to which genus it has to be transferred.

Subspecies CONSOBRINUS Sing., Mycologia 37:798. 1945.

Pileus more or less "madder brown" in the center, or in part "Pompeian red" or "diamine brown," margin "sepia" or "sepia" mixed with pallid, more rarely entirely olive brown, velutinous or very finely subtomentose-subgranulose, convex to applanate or flat to depressed in the center with steeper margin, 17-34 mm. broad. — *Hymenophore* yellow then greenish yellow, adnate-subdecurrent to adnate-subsinuate; pores concolorous, slowly bluing on pressure when fresh, or unchanging, comparatively rather wide. — *Stipe* "pinnard yellow" above, "madder brown" in the middle, and with a striking "pale greenish yellow" mycelial tomentum at the base, neither granulose nor floccose-squamu-

lose but smooth and glabrous or very minutely (use lens) subpruinose, solid, subequal or tapering downward, 32-37 x 3.5-6.5 mm.; mycelium yellow. — *Context* yellow, either unchanging or slightly and slowly bluing; odor disagreeable, reminding one of old, dirty clothing; taste mild.

Spores 9.2-11 x 4.7-5.4μ, comparatively broader and shorter than in other subspecies of this grex, melleous, with a slight suprahilar depression or without depression, smooth; *basidia* 25-38 x 10.2-10.5μ, 4-spored; *cystidia* 41-64 x 7.5-10.5μ, ventricose in the middle with ampullaceous apex, hyaline to pale melleous, not visibly incrusted, rather numerous at pores, scattered in the tubes; *trama* and *cuticle* as in the preceding subspecies.

Chemical reactions not studied.

Habitat.—In tropical hammock on lime rock soil, solitary or in small groups, fruiting from October till November.

Distribution.—Tropical Florida.

Material studied.—FLORIDA, DADE CO., Matheson Hammock, *R. Singer, F 1251,* TYPE (FH); *F 1454* (FH).

Subspecies DUMETORUM Sing., Mycologia 37:798. 1945.

Pileus "vinaceous rufous" or between "madder brown" and "brick red," or "brick red," or colored in the latter shade on the granulae which stand out upon a paler ground (thus making the general impression "vinaceous russet" to "cameo brown"), often pale yellow or "sulphur yellow" on the extreme margin, velutinous, especially on the young margin, or granular, especially on adult, larger specimens, non-viscid, usually unchanging when touched but sometimes bluing on the margin when touched, convex, the center often nearly flattened or depressed, 16-55 mm. broad. — *Hymenophore* yellow, becoming more greenish or olivaceous, in some specimens becoming stained with reddish brown when old, usually bluing or greening when touched, adnate or slightly to deeply depressed around the stipe, very often showing a narrow lamellate zone around the stipe; pores concolorous with the tubes, rather wide, angular; spore print "olive brown." — *Stipe* variable in color, the lower larger part yellow or "onion skin pink," or reddish brown granular or yellowish brown granular on yellowish ground, the apex always and the base usually yellow (concolorous with the young pores) and there also reddish brown or yellowish brown granular, or glabrous both above and below the granular zone, or either above or below, the granulation often rather in form of a minute flocculose punctation (use lens) rather than of conspicuous granulae, but always present in all specimens, dry, equal, mostly pointed-acuminate at the base, straight or curved or sometimes flexuous, solid, 22-83 x 5-10 mm.; mycelium usually forming a more or less conspicuous tomentum at the base, yellow or sulphur yellow. — *Context* yellow, in most cases not bluing when injured, rather firm, fleshy and rather thick; odor none; taste mild.

Spores 9.5-13.7 x 4.3-5.5μ, brownish or melleous, ellipsoid-fusoid, with suprahilar depression; *basidia* 31-34 x 10-13.5μ, 4-spored; *cystidia* 45-70 x 7-14μ, fusoid, often with an ampullaceous neck (10-29 x (4)-55μ), numerous at the pores, hyaline or melleous, more scattered in the tubes; *trama* truly

bilateral of the *Boletus*-type, with bright yellow pigment which disappears readily in ammonia, with a looser lateral stratum or distinctly and entirely divergent hyaline hyphae, and a melleous, denser, axillar mediostratum with parallel-subinterwoven, more frequently septate, thinner hyphae; *cuticle* with erect hyphae forming a palisade, the terminal members dermatocystidium-like, cylindric to subulate, rarely subcapitate, 14-40 x 6-11 μ, the pre-terminal hyphae short, often as broad as long, short-cylindric or vesiculose, with rather thin to very moderately thickened walls; *tomentum* of the stipe yellow, not entirely losing its pigment in NH_4OH, consisting of very irregularly interwoven hyphae of varying diameter but mostly 0.7-2.5-(6.8) μ thick; all *hyphae* without clamp connections.

Chemical reactions not studied.

Habitat.—In tropical hammocks in the deep shadow of mixed frondose, mostly evergreen trees on lime rock soil or on very decayed wood, frequently but probably not always near *Quercus virginiana*, solitary to gregarious, fruiting from September (or possibly earlier in the rainy season) till October.

Distribution.—Dade County, Florida.

Material studied.—FLORIDA, DADE CO., Miami, Simpson Park, *R. Singer, F 695*, TYPE (FH); Matheson Hammock, *R. Singer, F 695 a* (FH); *F 1384* (FH); Royal Palm State Park, *R. Singer F 1256 a* (FH); all CO-TYPES.

Forma **crassotunicatus** f. n.

Pileo olivaceo, trichodermio ex hyphis erectis, crassotunicatis efformato recedit. In dumetis tropicalibus.

This differs from the type of this subspecies in the members of the trichodermium of the pileus being thick-walled (diameter of the walls 0.5-2.0 μ, mostly around 1.3 μ); macroscopically, for some reason or other, this seems to show in color. The cuticle which has been red in fresh condition is now a pure olive color; no yellow pigment-solution did come out of the hymenophoral hyphae in NH_4OH; cystidia mostly hyaline, fusoid-ampullaceous; not otherwise different from the type form. On earth in tropical hammock. Known only from the type locality; Matheson Hammock near Miami, Dade Co., Fla., October 8, 1942, *R. Singer, F 976*, TYPE (FH).

Subspecies CARIBAEUS Sing., Mycologia 37:798. 1945.

Pileus "brick red," "Japan rose," "terra cotta," or some similar color, not carmine-purple, often discolored to olive brownish or olive gray ("dark olive drab," "ecru olive"), distinctly tomentose and non-viscid, especially strongly so on the margin, more subtomentose in the center after a while and generally glabrescent with age and at the same time cracking into areolae, becoming rimose with yellow crevices, rather pale and very opaque in dried condition (much more so than *B. rubricitrinus*), pulvinate with the center sooner or later applanate or depressed, 40-70 mm. broad. — *Hymenophore* yellow, becoming more olivaceous when old, bluing where touched, adnate and often somewhat depressed around the stipe; tubes 6 mm. long, or somewhat longer; pores rather wide (0.7-1.5 mm. in diameter, towards the stipe frequently wider, 1-2 mm.), concolorous; spore print "olive brown." — *Stipe* sordid pale yellow-

ish or sometimes partly sordid pale pinkish, the base some shade of yellow, rarely a deep Corinthian red (not "madder brown" as in *B. rubricitrinus*) at the base, covered with flocculose squamulae or furfuraceous floccons of any of the above named colors but usually not prominently red or pink but predominantly yellowish, dry, subequal or often tapering downward, the base often pseudorhiza-like, solid, 58-67 x 10-25 mm.; mycelium sordid, not yellow, forming a basal tomentum, or inconspicuous. — *Context* yellow in the pileus and the upper portion of the stipe, bluing when bruised, in the base of the stipe yellow mixed with reddish pink, in the very root-like base beneath, yellow again inside and outside; odor none; taste mild.

Spores (9.5)-10-14.2-(14.5) x 4.2-6.5μ mostly 11-11.7 x 5μ, broadly fusoid, rather thin-walled to quite thin-walled, with suprahilar depression, brownish melleous, well colored, smooth; *basidia* 29-42 x 10.5-12.5μ, (1)-4-spored with about 5.5μ long, half sickel-shaped sterigmata which are connected with the spores at a hilar point distinctly outside the longitudinal axis of the spore (spores asymmetric[8]); *cystidia* 23-70 x 7.5-11μ, fusoid to fusoid-subampullaceous, hyaline, some (either a majority or a minority) covered with a strongly appressed resinous, melleous incrustation, moderately numerous to numerous on the pores, more scattered in the tubes; *trama* of the hymenophore truly bilateral, of the *Boletus*-type, the mediostratum slightly colored melleous, and denser than the lateral stratum which consists of rather loosely arranged, hyaline and decidedly divergent hyphae; all *hyphae* without clamp connections.

Chemical reactions.—KOH everywhere brown. NH_3 and NH_4OH reactingly indistinctly, making the pileus more dirty olive. HCl on surface of pileus, negative. — $FeSO_4$ olive grayish.

Gastroid conditions.—These are similar to those formed by *Boletinus decipiens* though differing in being comparatively much larger; they have the color of the pileus of a normally developed carpophore, and all truly gastroid stages were found to be sterile and remaining sterile. They are met with together with the normal form.

Habitat.—In dry pine land (*Pinus caribaea*) of the tropical zone of South Florida, on poor, rocky lime soil, also on lawns along pine lands, often in the shade of leguminous trees or *Ficus* but evidently associated with pine, in groups, fruiting from September till November.

Distribution.—Dade Co., Fla.

Material studied.—FLORIDA, DADE CO., Fairchild Tropical Garden, along the stone wall, often hidden in dense shrubbery, *R. Singer, F 1370,* TYPE (FH); Coral Gables, lawn under *Pithecolobium* near pines, *R. Singer, F 1119,* (FH); Coral Gables, *Dr. Buswell* (det. R. Singer), *F 1093* (FH); Woodlawn Park Cemetery, just oustide the cultivated lot in dry pine land, *R. Singer, F 1288* (FH), all CO-TYPES.

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8 This is the type generally found in Agaricales. Like the spore attachment in *Boletinus decipiens*, it differs from what we find in those Gastromycetes with a structure comparable to that of the gastroid forms of both *B. rubellus* ssp. *caribaeus* and *Boletinus decipiens*. Otherwise one would rather be inclined to consider the boletes as boletoid stages of certain Gasteromycetes, while, actually, they are atavistic forms re-establishing an angiocarpous development but retaining the advanced way of spore-formation acquired by pseudoangiocarpous and gymnocarpous development.

Forma **serotinus, f. n.**

Sporis majoribus praesentibus (usque ad 16.3μ) differt. In hortis in Coral Gables serotinus.

This differs from the typical form of the subspecies, so common in Dade Co. in fall, in having a higher maximum spore length. The spores are 10-16.3 x 4.5-6.8μ, most frequently 12.5 x 5.5μ. These rare late specimens, collected by the writer in mid-November during a dry but cooler spell, do not otherwise differ from ssp. *caribaeus* and are here considered as a seasonally aberrant form. The same mycelium also produced a sterile, gastroid condition which was, naturally, indistinguishable from the gastroid stage of the type form.

Subspecies BICOLOROIDES Sing., Mycologia 37:798. 1945.

Pileus "Pompeian red" to "dragon's blood red," discoloring to "Dresden brown" or "Isabella color," very minutely areolate-subgranular to rimulose-subtessellate, never viscid, convex to flat, 24-52 mm. broad. — *Hymenophore* yellow, soon inclining to become greenish and eventually reaching almost "citron green," slightly depressed around the stipe, with short decurrent ribs on the very apex of the stipe; pores rather wide and irregular, mouths of irregular depth, concolorous and changing to green or blue when touched, at least when young and fresh; spore print "olive brown." — *Stipe* more or less yellow at the apex, farther downwards concolorous with the pileus or "mineral red" near the base, subglabrous, but under a lens extremely minutely subflocculose, not reticulate but coarsely longitudinally ribbed by innate fibers, subequal, solid or stuffed, 28-64 x 5-12 mm.; mycelium not very abundant, pallid cream white, or at places yellowish white. — *Context* yellow, bluing readily in all parts when exposed; odor slight, somewhat in between the odor of *B. edulis* and *B. auripes;* taste mild.

Spores 10.2-14.5 x 4-6μ, mostly 11-13.7 x 4.5-5.5μ; *cystidia* with ampullaceous apex; otherwise about as in *B. rubellus* ssp. *bicolor* (Peck) Sing.

Chemical reactions.—NH_4OH on surface of pileus a slate blue ring around a fulvous to olive stain.

Habitat.—In high hammocks under oaks and in deciduous woods or under frondose trees on lawns, fruiting from July till September in small groups, singly or cespitosely.

Distribution.—North Florida, possibly north to Virginia along the Atlantic Coast.

Material studied.—FLORIDA, ALACHUA Co., Sugarfoot Hammock, *R. Singer, F 2537,* TYPE, (FH); Gainesville, *R. Singer, F 2669,* (FH). ?VIRGINIA, Richmond, *D. H. Linder & R. F. Smart* (FH).

Extralimital Subspecies of B. rubellus and Related Species

B. rubellus Krombh. ssp. **bicolor** (Peck) Sing. comb. nov.

Boletus bicolor Peck, *l.c.*, and other combinations with this epithet.
Boletus rubeus Frost, *l.c.*, and *Suillus rubeus* Kuntze *l.c.*

Though not recorded in Florida, this has been found as far south as Georgia and Tennessee. In order to prevent confusion with the other subspecies of *B. rubellus,* we shall describe ssp. *bicolor* in the same manner as the others.

Pileus "madder brown" to "ocher red," tomentose, dry or very slightly viscid in rainy weather, slightly rimulose with the flesh showing in the crevices being yellow, discoloring to "Dresden brown," or paler from the disc outward, pulvinate, then convex with applanate or less convex center, eventually often partly depressed, or irregular, 50-140 mm. broad. — *Hymenophore* "straw yellow," then more greenish and olivaceous, adnate or slightly depressed around the stipe; tubes 6-14 mm. long; pores concolorous with the tubes, moderately rapidly and moderately strongly bluing when touched, at least when quite fresh, scarcely 1 mm. wide in medium sized carpophores near the stipe, smaller (of the size of these of *B. miniatoolivaceus*) toward the margin, or more rarely all medium wide; spore print "olive brown." — *Stipe* deep yellow at the very apex or at a rather wide apical zone, "Pompeian red" to "madder brown" below, but tending to become as olive as the pileus, "Isabella color" at places, rugulose, subglabrous, *i.e.* extremely faintly flocculose-punctulate (but hardly visible to the unaided eye), variable in shape, solid, straight or curved, 40-95 x 8-23-(35) mm.; mycelium sordid white, reaching pale salmoneous ochraceous, but never yellow, not even light yellow, usually inconspicuous, more rarely forming a strong basal tomentum. — *Context* light yellow, deeper yellow at places and when exposed for a long time, bluing but not immediately, and not very strongly so, occasionally almost unchanging; odor of radishes, or of *Leucocoprinus procerus,* or of garlic, especially some time after the carpophores have been picked, sometimes none; taste agreeable.

Spores 9-12.2-(13.5) x 3.5-5μ, mostly 11 x 4μ, pale melleous to melleous, cylindric-fusoid, with slight suprahilar depression and tapering apical portion, smooth; *basidia* 21-28 x 8.8-10.5μ, (1)-4-spored; *cystidia* 21-48 x (3.5)-4-7.5μ, subulate-fusoid or fusoid-ampullaceous, rather versiform, hyaline with moderately thin wall, rather numerous at the pores, somewhat more scattered in the tubes; *trama* truly bilateral, of the *Boletus*-type; *cuticle* consisting of a trichodermium whose hyphae are for the most part organized in a palisade, but with intermingled spherocysts of about 14μ diameter which, however, do not form an epithelium; all *hyphae* without clamp connections.

Chemical reactions not studied.

Habitat.—In frondose and mixed woods under Fagales on the ground, in small groups, singly or cespitose, fruiting from June till October.

Distribution.—From New England to Georgia and the Great Lakes region to Tennessee and Missouri.

Material studied.—VERMONT, TYPE of *B. rubeus* Frost (FH). MASSACUHSETTS, Woburn, *W. L. White* (det Singer, conf. Snell) (FH); Prospect Hill, *Farlow* (FH). NEW YORK, TYPE of *B. bicolor* Peck (NYS). NORTH CAROLINA, Chapel Hill, *Alma Holland* (*Beers*), *11102* (as *B. communis*) (FH). TENNESSEE, Elkmond, *L. R. Hesler* (FH, similar material in FLAS); Laurel Falls, *A. H. Smith, 10441* (FH). We have also material from Devil's Lahr, Wis., with smaller pores, determined as *B. bicolor* but possibly different.

BOLETUS PERNANUS Pat. & Baker, Journ. Straits Branch R. A. Soc. 78:72. 1918.

Plate 1, Fig. 9

The type (FH) shows slender, small fruit bodies with strikingly yellow mycelial tomentum; spores 9-12.6 x 3.7-5.3μ, without suprahilar depression

or with a very slight one, the apex often attenuate, melleous brownish with a golden glimmer, now often with dark brown pigment-granulae, relatively rather thick-walled; cystidia hyaline, fusoid-ampullaceous or fusoid; the sulphur yellow mycelium of the base consisting of long filaments of (in NH_4OH) hyaline, 2-3.5μ thick, thin-walled hyphae; the cuticle consisting of a trichodermium of ascendant, cylindric hyphae, with the last members erect, forming an epithelium of ovoid to globose bodies, only scattered clavate terminal hyphae or dermatocystidia interrupting this epithelium; all hyphae without clamp connections.

This Singapore species seems to be most closely related to the remaining species of this section, especially to the small tropical forms from the same general region. It is too early to decide whether or not the epithelium of the pileus is sufficient reason for a sectional separation.

Boletus Patouillardii, spec. nov.

Pileo pulchre rubro, sicco, opaco, 4-10 mm. lato in siccis; hymenophoro flavo, circum stipitum depresso zonamque angustam sublamellosam formante, tubulis moderate longis; poris mediocriter amplis sed pro ratione amplis, concoloribus; sporis 7.5-9.5-(10) x 4.5-5.5μ, brunneo-melleis, ellipsoideo-oblongis, (forma sua *Tylopilum Balloui* in mentem revocantibus), levibus; basidiis 28-30 x 7.5-10μ; cystidiis pororum 28-45 x 7.5-11.8μ, hyalinis, fusoideo-ampullaceis vel fusoideis; tramate hymenophorali typi *Boletorum;* stipite ad apicem flavo, ceterum pileo concolori, subglabro, subaequali, sicco, solid, fragili, 6-16 x 0.8-1 mm. in siccis; mycelio laete luteo sed tomentum basale haud formante, haud copioso; carnis colore haud observato; hyphis omnibus haud fibuligeris. Ad vias silvaticas, Reserve Forestière de Campong chhuong, Cambodge, Indo-China, Julio mense, *Petelot,* 222 (FH).

This species was collected and sent to Patouillard in 1921. Patouillard kept it in his herbarium under a herbarium name, but strangely enough not among the Boletaceae but—of all things—as a *Porolaschia.* If the writer had not by chance been interested in the *Laschia*-complex at the same time, this new *Boletus* would probably have escaped the attention of the specialists for a long time. This fungus and *B. pernanus* look very much alike in dried condition except for the mycelium which is much scantier in *B. Patouillardii.* The spores are definitely shorter than in *B. pernanus,* and the color of the fresh pileus and stipe should make the distinction of this plant easy. The cuticle is not in a condition that lends itself to anatomical analysis. It may belong to either the *Pernanus*-type or the *Nanus*-type, *i.e.* forming an epithelium, or forming a tomentum with elongate hyphae only.

BOLETUS NANUS Mass., Bull. Misc. Bot. Gard. Kew (1909):208. 1909.

I have not seen the type but I have seen two good collections in the Höhnel-Herbarium (FH) which undoubtedly belong here. The pileus is umber or olive umber, flocculose-tomentose or innately squamulose, dry, convex, about 28 mm. broad, deep brown in the herbarium; tubes and pores light yellow, or yellow, adnate or slightly depressed, rather short (about 4 mm.

long); pores rather small but in comparison with the diameter of the pileus rather wide; stipe light yellow, or somewhat reddish at the apex, yellowish brown in the middle and olive below, somewhat radicate at the base, smooth, longitudinally fibrillose, without distinct basal tomentum, cylindric, somewhat curved, about 26 x 5.5 mm.; mycelium yellow; context light yellow, bluing on exposure. Spores 8.2-10.2 x 4.5-5-(5.5) μ; hyaline to strikingly golden yellow, small, without suprahilar depression, thin-walled, smooth; basidia 25-31 x 7-8.2μ, 4-spored; cystidia 34-68 x 6.8-13.5μ, very crowded at the pores, hyaline, fusoid, apiculate; trama bilateral with a bright yellow denser axillar mediostratum of somewhat interwoven-parallel hyphae, and reaching a point near the pores (not the pores themselves), the lateral stratum hyaline, of distinctly divergent, more loosely arranged hyphae; cuticle of interwoven hyphae, the terminal members often ascendant, with distant septa, fulvous-melleous, often with the pigment concentrated in guttulae; all hyphae without clamp connections. The colors and measurements of the carpophores are given according to Höhnel's notes and sketch *in sched.*

This was originally described from Singapore but the above description refers to specimens from Tjibodas, Java.

BOLETUS AUREOMYCELINUS Pat. & Baker, Journ. Straits Branch R. A. Soc. 78:69. 1918.[9]

The type from Singapore (FH) has wide pores; spores about 7 x 5μ, pale melleous; hyphae of the bright yellow, abundant mycelial tomentum of the base filamentous, 2-5.5μ in diameter; the tomentum of the pileus consisting of melleous-citrinous strands of parallel or subparallel hyphae, or of single hyphal filaments, not forming a distinct palisade anywhere, the hyphae very variable in diameter, without clamp connections. This is obviously close to the preceding species. Though the exact color of the spore print is not known for either of them, the combination of the known characters strongly suggests this section rather than the genus *Tylopilus* where no related species exist.

Species Imperfectly Known

BOLETUS PARVUS Peck, Bull. Torr. Bot. Cl. 24:145. 1897.

The data on this plant may be found in Coker & Beers, *l.c.*, p. 39. Its generic position is not quite certain. It was described from Alabama, and Coker & Beers think they have re-collected it in North Carolina. Its main features are small (1-2 in.) reddish pileus, rather large, bright red pores.

Section LURIDI Fr., Epicrisis, p. 417. 1838.

Suillellus Murr., Mycologia 1:16. 1909, (*ut* genus).

Characters of the section: The difference between this and the section *Apendiculati* consists in the reddish or brown pores, *or* the non-reticulate stipe in the former section. The *Luridi* differ from the section *Subpruinosi* in

9 In the original paper, the name is spelled "aureomycetinus" but this is obviously a printing error since the specimens are correctly labeled as above.

smaller pores. Some species with definitely concolorous pores during their entire development are very close to the *Luridi* in the old sense *i.e.* to species with red pore mouths. This fact becomes still more evident if varieties with permanently concolorous pores of species with typically discolorous pores, or varieties with discolorous pores of species with typically concolorous pores are considered (see nos. 18 and 25). This shows that the section *Luridi* had to be emended to include certain species with concolorous pores. Though the color of the pores is a convenient character for determination, it has, in many cases, little bearing on questions of natural affinity between species.

The section *Luridi* of the genus *Boletus* contains the only known poisonous species of the Boletineae. Amateurs should be careful not to experiment with any of these species since even a small quantity of the poisonous carpophores may cause serious illness though none is believed to be as deadly as the Amanitae of the Phalloides group (*A. phalloides, A. brunnescens, A. verna, A. virosa*). *B. satanas, B. luridus* and *B. miniatoolivaceus* have notoriously caused ill effects on people who ate them though the amount of poisonous matter seems to vary either regionally, or perhaps according to climatic factors. The susceptibility of different persons also varies to a certain degree.

The type species of the section *Luridi* is *Boletus luridus* Schaeff. ex Fr.

KEY TO THE SPECIES

A. Pores concolorous with the tubes (yellow).
B. Pileus pink, red, testaceous, vinaceous-rufous, purplish, or yellow.
C. Pileus pallid leather ocher; context usually little or not changing when exposed to the oxygen of the air ..... (*B. impolitus*)
C. Pileus not colored as above; context usually distinctly bluing in fresh material.
D. Spores 5μ or broader.
E. Pileus prevalently red or reddish; spores 12.5-18.8 x (4.5)-4.8-7.7μ, mostly (14)-15-(17) x 5-5.5μ; stipe flocculose-squamulose.
F. Pileus strongly viscid when wet ..... *B. dichrous*
F. Pileus not strongly viscid when wet ..... 25. *B. rubricitrinus*
E. Pileus not or not prevalently red (only with a superficial red covering in young specimens and possibly some red or pink areas alongside the prevalent bright yellow color of the adult specimen); spores distinctly shorter than indicated above: "(10)-11-15-(17) x 5-6.5μ" according to Kallenbach in Europe ..... *B. junquilleus* (cf. also *B. Queletii*, see p. 65-66 and p. 79)
D. Spores up to 5μ broad.
G. Pileus prevalently bright golden yellow when mature with somewhat shining cuticle in dry weather, the purplish carmine floccons or fibrils all disappearing in early youth; base of the stipe inside and out deep carmine, at least constantly so in mature specimens; odor slight, agreeable, or none, slightly cumarinous when dried ..... 19. *B. flavissimus*
G. Pileus usually prevalently red or pink though occasionally fading to olive or brownish, leaving large yellow areas in some specimens and rarely remaining yellow instead of some kind of red, always opaque; base of the stipe rarely with carmine colors; odor though weak yet characteristic, disagreeable, variable (of onion, garlic, spoiled meat, cumarine, etc., see description) when fresh and especially some time after collecting, cumarinous when dried ..... 18. *B. miniatoolivaceus*
B. Pileus without reddish, purplish, pinkish, etc. tones, and also not yellow.
H. Pileus pallid leather color; context usually not changing on exposure ..... *B. impolitus*

H. Pileus differently colored (brown); context usually readily bluing.
I. Stipe not carmine but umber brown in the base, its apex without a network, merely finely flocculose ..... 23. *B. oliveisporus*
I Stipe not umber brown but carmine in the base of mature specimens, its apex almost constantly with a narrow zone of fine reticulation which a few millimeters from the point of attachment of the tubes, is replaced by minute floccons ..... 24. *B. luridellus*

A. Pores discolorous as compared with the tubes, *i.e.* tubes yellow, then olivaceous, and pores red from the beginning or with maturity, often dusky red, or in some cases rather brown.
J. Stipe without distinct reticulation, or with an indistinct very fine one continuing from the line of attachment of the pores on the apex of the stipe for a distance of no more than one-fourth of the length of the stipe, but much more frequently no reticulation of any kind is observed on the stipe.
K. Spores in average twice as long as broad (Q=2), 5-7μ broad, rarely broader; basal tomentum indistinct. Old-world species ..... *B. Queletii*
K. Spores, if as broad as indicated above, at least in their majority somewhat longer than two times their breadth; or, if the spores do have a Q around 2, they are American species with a very well developed basal tomentum.
L. Pileus "vinaceous brown" on the margin, "sorghum brown" on the disc, tomentum of the base between "Isabella color" and "buffy citrine" (*i.e.* olivaceous); dried pileus usually "sorghum brown" on the margin and "vinaceous buff" in the center (if prepared carefully); spores 9.5-12.2 x 4.2-5.5μ. Tropical Florida ..... 20. *B. austrinus*
L. Not combining the above indicated characters.
M. Basal tomentum very prominent, reaching high up the stipe; spores 9.2-13.8 x 5.5-6μ. Western species ..... *B. tomentipes*
M. Not combining a strong basal tomentum with spores of the above size.
N. Pileus pinkish red, vinaceous-testaceous; spores large (13.5-16.3 x 4.8-5.5μ). Tropical Florida ..... 25. *B. rubricitrinus* var. *Fairchildianus*
N. Not combining the above color with the above spore measurements, and not occurring in tropical Florida (but some occurring in extra-tropical Florida).
O. Pileus brownish to deep brown, very rarely with red or yellow light spots or red or yellow portions.
P. Pores and floccons of the stipe (if present) red, dusky red.
Q. Stipe not glabrous, or if it is glabrous above, it shows a distinct lines on white ground, otherwise similar to *B. subvelutipes* except for the spores which are somewhat smaller (8.5-11.5 x 3.5-3.8μ in the type) ..... 21. *B. hypocarycinus*
Q. Stipe not glabrous, or if it is glabrous above, it show a distinct velvety to strigose basal tomentum.
R. Context bluing; pores bluing; mycelium rarely bright yellow (*B. erythropus*) and ..... 22. *subvelutipes*)
R. Context reddening, not bluing; pores reddening, not bluing; mycelium bright yellow ..... *B. Morrisii*
P. Pores and floccons of stipe brown ..... *B. vermiculosus*
O. Pileus red, sometimes mixed with yellow, frequently discolored, at least in part, to brownish or olive; stipe indistinctly and inconstantly minutely flocculose or subglabrous.
S. Stipe subglobose-bulbous ..... (*B. Eastwoodiae*)
S. Stipe thick and ventricose to subequal, or tapering upwards or downwards, not subglobose-bulbous.
T. Spores large (12-18 x 4-6μ); odor weak and agreeable or none.
U. Pileus viscid, bright red (about the color of the most usual form of *B. Frostii*); Mediterranean ..... *B. Dupainii*
U. Pileus sometimes slightly sticky in rainy weather, but not distinctly viscid, drying rapidly; color not uniformly bright and deep red, only occasionally with some brown-red or

or orange red mixed in, very rarely prevalently in these latter colors .....(*B. erythropus*)

T. Spores smaller; odor more or less distinctly disagreeable, of onion, garlic, spoiled meat, cumarine, etc. (like that of *B. satanas*) .....18. *B. miniatoolivaceus* var. *subluridus*

J. Stipe with a distinct network, normally (*i.e.* in the majority of the carpophores of a group) covering one quarter or rather more of the length of the stipe.

V. Pileus usually pale sordid white, or pale sordid grayish cream color, or with a greenish tinge, and becoming somewhat brownish only in old specimens; sometimes with a flush of light purplish pink but never carmine red, not orange, not deep yellow, not deep olivaceous, and never deep brown from the beginning; stipe bulbous and remaining so, or becoming stretched with age, with a very fine reticulation of little raised red lines which form meshes that are not or not much longer than broad, the base of the stipe usually not so strongly carmine red, vinaceous, olivaceous, etc. as in *B. luridus;* odor very weak, agreeable, or almost none, or, though slight, yet distinctly disagreeable as in *B. miniatoolivaceus.*

W. Reticulattion constantly confined to the very apex of the stipe; stipe subglobose-bulbous; pileus usually pink, or prevalently pink. Western species .....*B. Eastwoodiae*

W. Not as above, or not combining the above characters.

X. Odor weak, agreeable or none; stipe at maturity elongated; pileus often with a pinkish, never with a greenish tinge .....*B. rhodoxanthus*

X. Odor weak to rather strong, disagreeable, like that of *B. miniatoolivaceus;* pileus often with a greenish, never with a pink hue .....*B. satanas*

V. Pileus well colored at maturity, either brown, or with bright red orange, olive, yellow, or pink colors; stipe bulbous but soon elongated and eventually cylindric with a rather strongly elevated reticulation, the meshes of which are strongly longitudinally elongated, the resulting network usually running down over one half or more of the length of the stipe, the inside of the base deep carmine red, deep vinaceous, deep olive, or orange red if the ground color of the stipe is not thoroughly yellow (aside from discolorations); odor agreeable and very weak, or none.

Y. Raised lines of the reticulation of the stipe strongly projecting and, at least on a part of the stipe, red on red ground; pileus deep red, or entirely pink. American species .....26. *B. Frostii*

Y. Raised lines of the reticulation moderately strongly elevated, usually red on yellow ground but later often discolored. European species, probably not occurring in America .....*B. luridus*

SIMPLIFIED KEY TO THE FLORIDA SPECIES OF SECTION LURIDI

A. Pores concolorous with the tubes, yellow.

B. Pileus red, or some shade of reddish.

C. Floccons of the stipe distinct; spores 12.5-18.8 x (4.5)-4.8-7.7μ mostly (14)-15-(17) x 5-5.5μ; odor none or very slight and agreeable; base of the stipe usually deep red inside .....25. *B. rubricitrinus*

C. Floccons of the stipe indistinct or very small and forming a glabrous surface as seen with the unaided eye; spores smaller than indicated above; odor disagreeable a while after picking; base of stipe mostly not deep red inside. Rare. .....18. *B. miniatoolivaceus*

B. Pileus not red (or only somewhat reddish at places, especially where not exposed to light and water).

D. Pileus bright yellow (or prevalently so at least in mature specimens) .....19. *B. flavissimus*

D. Pileus some shade of brown.

E. Stipe not carmine but umber brown in the base, its apex without a network, merely finely flocculose .....23. *B. oliveisporus*

E. Stipe not umber brown but deep carmine in the base of mature specimens, its apex almost constantly with a narrow zone of fine reticulation which, farther downwards, changes into minute flocculosity .....24. *B. luridellus*
A. Pores discolorous, red.
F. Stipe without a distinct network (except perhaps a very narrow belt at the very apex of the stipe).
G. Pileus about "sorghum brown" in dried caps; stipe with a strongly strigose olivaceous basal tomentum .....20. *B. austrinus*
G. Pileus differently colored; if the stipe shows a strong basal tomentum, the latter's color is usually red or rusty-red.
H. Pileus brown.
I. Spores 8.5-11.5 x 3.5-3.8μ in the type; stipe red punctate and red-lined on whitish ground; basal tomentum inconspicuous ....21. *B. hypocarycinus*
I. Spores larger; stipe usually strongly red flocculose to red squamulose on yellow ground; basal tomentum strigose, red to rusty red .....
.....22. *B. subvelutipes*
H. Pileus red.
J. Floccons of the stipe distinct. South Florida .....
.....25. *B. rubricitrinus* var. *Fairchildianus*
J. Floccons of the stipe indistinct. North Florida .....
.....18. *B. miniatoolivaceus* var. *subluridus*
F. Stipe very distinctly reticulate .....26. *B. Frostii* ssp. *floridanus*

Description of the Species Occurring in Florida

18. BOLETUS MINIATOOLIVACEUS Frost, Bull. Buff. Soc. Nat. Sc. **2**:101. 1874.

Boletus sensibilis Peck, Rep. N. Y. State Mus. **32**:33. 1879.
Boletus miniatoolivaceus var. *sensibilis* Peck, Bull. N. Y. State Mus. **2**(8):107. 1889.
Boletus Underwoodii Peck, Bull. Torr. Bot. Cl. **24**:145. 1897 (a variety).
Suillus miniatooliveus (*sic*) Kuntze, Rev. Gen. Pl. **3**(2):536. 1898.
Ceriomyces miniatoolivaceus Murr. Mycologia **1**:152. 1909.
Suillellus subluridus Murr., Mycologia **30**:524. 1938. (a variety).
Boletus subluridus Murr., *l.c.*, p. 525. (a variety).

Var. TYPICUS

Description of the Northern Form

Pileus "testaceous" to "Etruscan red" or almost "jasper red" or "orange vinaceous," but often deeper red in young specimens and paler pink) in old ones, usually partly, rarely entirely becoming discolored assuming an olivaceous to brownish alutaceous tinge (*e.g.* "old gold"), suède-like to distinctly tomentose, somewhat viscid in rainy weather but drying rapidly and usually found in dry condition, often becoming reticulately rimose with the deep yellow flesh showing through, convex then more or less applanate, 60-160 mm. broad. — *Hymenophore* "amber yellow" or "pinard yellow," subplane beneath, adnate, or adnate-subdecurrent, or slightly depressed around the stipe, often separating in age; tubes 6-11 mm. long; pores concolorous or more rarely the more projecting tube-walls red-tipped (with "orange rufous"), bluing when touched, small or somewhat wider up to (0.8 mm.) near the stipe, 8-14 pores to 5 mm.; spore print brownish olive. — *Stipe* "baryta yellow" with some pink or red stripes or dots (between "dragon's blood red" and "Etruscan red") also usually with "light cadmium" stains near the base, later becoming orange yellow in some cases, at last sometimes brown fibrillose, sometimes "Pompeian

red" at the base, glabrous or extremely faintly flocculose-punctulate (use a lens), solid, equal, or sometimes subfusoid, or tapering upwards, more rarely tapering downwards from the apex, solid, 70-125 x 18-28 mm.; mycelium sordid whitish to light yellow or pale alutaceous. — *Context* "baryta yellow" (or paler in the pileus), bluing either strongly to deep indigo or weakly to greenish blue, changing either rapidly or slowly when injured, long-exposed flesh becoming deep golden yellow ("light cadmium"); odor at first very faint, and mostly more or less agreeable, in old specimens, especially after lying in the laboratory for a few hours, decidedly disagreeable but hard to define, much like the odor of spoiled meat, or of onion or garlic, or of rancid fat, or cumarinous (probably varying), always more or less cumarinous when dried.

Spores (8.5)-10-14-(14.5) x (3.5)-4-5-(7) μ, melleous or pale melleous, ovoid-oblong or fusoid, smooth; *basidia* 20-25.5 x 7.5-10μ, 4-spored; *cystidia* 30-50 x 6-12μ, fusoid to fusoid-ampullaceous or subclavate hyaline; *trama* truly bilateral of the *Boletus*-type; *cuticle* filamentous, frequently with some spherocysts intermingled on the surface; all *hyphae* without clamp connections.

Chemical reactions.—KOH on surface of pileus, olive yellow and rapidly becoming olive green, then olive bronze, in the red portions usually with red marginal ring around the stain; on context of stipe, rusty ochraceous, then duller; NH_4OH on surface of pileus, orange yellow, often with a caesious marginal ring around the stain; on context of stipe often greening; HNO_3 on surface of pileus becoming deep red, or remaining red, reddening even the yellow portions; on context of stipe, rusty ochraceous, then avellaneous.

Habitat.—On the earth in frondose and mixed woods under *Fagus grandifolia, Betula* and *Quercus* (several species). Fruiting from July till September.

Distribution.—From Canada to the Carolinas and west to the Pacific Coast.

Material studied.—MAINE, near Camden, *Linder & Singer, ME 12* (FH). VERMONT, Brattleboro, probably TYPE, *Frost* (FH). MASSACHUSETTS, Canton, *Linder* (det. Snell) (FH); Wakefield, *Singer M 104* (FH). RHODE ISLAND, East Providence, *W. G. Farlow*, on sheets and in boxes, also unpublished color plate (FH). NEW YORK, TYPE of *B. sensibilis Peck* (NYS); *Murrill* (NY). VIRGINIA, Petersburg, *Linder & Smart* (det. Singer) (FH); Mountain Lake, *Linder* (det Linder & Overholts) (FH); Danville, *R. S. Phifer* (det Peck, as *B. roseotinctus* (NYS). OREGON, Mt. Shasta, *W. B. Cooke* (det Snell) *14628* (FH).

Description of the Florida Form

Pileus "Corinthian red" or "deep Corinthian red," or between "orange vinaceous" and "Etruscan red," or "Etruscan red" to "ocher red," or "dragon's blood red," often the covered places or in the folds pallid to yellow, rarely entirely yellow with a slight fugacious pink hue, glabrous to subvelutinous, somewhat viscid-sticky when wetted by rains but rapidly drying out, opaque or more rarely partly shining when dry, smooth, pulvinate, then expanding, 70-154 mm. broad. — *Hymenophore* yellow, adnate to somewhat depressed around the stipe; tubes moderately long; pores concolorous or occasionally the projecting dentate tube-walls tipped with "orange rufous," slowly and moderately strongly bluing on pressure if quite fresh, otherwise practically unchanging, small, subequal; spore print as in the northern form. — *Stipe*

yellow, mixed with pink or reddish because of extremely minute (use a lens) reddish rarely partly brownish or yellowish floccons which are irregularly crowded or scattered, not distinctly flocculose-squamulose, but causing the stipe to be very faintly pruinose at places, the base sometimes deeper red, everywhere smooth except for the very apex which is mostly covered by a very narrow inconspicuous orange or yellow reticulation in continuation of the pores, this reticulation composed of non-elongated to slightly elongated meshes of very fine (use lens), very slightly raised lines, sometimes with a brownish zone between this reticulate belt and the main portion of the stipe, sometimes entirely subglabrous and the floccons not visible even with a lens, solid, variable in shape, 40-110 x 18-45 mm.; mycelium of mixed yellowish and whitish filaments. — *Context* yellow, bluing when injured but not very rapidly and moderately strongly, becoming deep golden yellow (about "light cadmium") on long exposure or when wounds are dried, firm, thick in the pileus, later very soft and spongy; odor slight but distinct, disagreeable, of spoiled meat or onions or garlic, or cumarine, always cumarinous when dried; taste mild.

Spores 11.5-13.5 x 3.5-4.2μ, ellipsoid-oblong to subcylindric or subfusoid, smooth, melleous; *basidia* 20-25 x 7-9μ, 4-spored; *cystidia* 34-48 x 6.7-11.2, melleous, fusoid with ampullaceous neck, rather numerous; *trama* as in the northern form.

Chemical reactions, as in the northern form.

Habitat.—On the ground in high and mesophytic hammocks, near oaks, especially *Quercus virginiana* and *Q. laurifolia*. Fruiting in summer (mostly from June to August).

Distribution.—North Florida, northern and western limits unknown.

Material studied.—FLORIDA, ALACHUA CO., Gainesville, *Singer, F 2610 a* (FH); also additional material without number, July 1943 (FH); Newnan's Lake, *Murrill* (det. Singer), *F. 2073* (FH).

Var. SUBLURIDUS (Murr.) Sing., Mycologia 37:798. 1945.

Suillellus subluridus Murr. and *Boletus subluridus* Murr., *l.c.*
Boletus Underwoodii Peck, *l.c.*

Pileus "coral pink" to almost "jasper red," "Etruscan red" or "ocher red," sometimes with deep yellow ("deep chrome") portions, then showing a mixture of "vinaceous tawny" and "jasper pink," or becoming "vinaceous rufous," "ferruginous," or "cinnamon rufous," or partly buff discolored, subvelutinous, glabrescent, rimulose in age, or with an entire cuticle, sometimes with deep cracks showing the deep golden yellow ("light cadmium" or deeper) flesh through the crevices, usually dry but subviscid to viscid-sticky when exposed to rains for some time, convex then expanding, 50-110 mm. broad or rarely broader. — *Hymenophore* "sulphur yellow" to "pale green yellow," becoming "light calcedony yellow," (except for the discolorous pores), bluing on injury, depressed around the stipe in adult specimens; tubes 6-11 mm. long; pores either partly concolorous with the tubes, the yellow superseded by a shallow red tinge, or "Estrucan red" to "ocher red," or "Pompeian red" to almost "carmine" all over, frequently bluing on pressure when very fresh; spore print between "syrup" and Pl. 15, L 9 (M. & P.) when approximately 5 years old,

possibly better preserving the olive color than other species, especially those of sect. *Calopodes*. — *Stipe* "Eugenia red" to "jasper red" or "Pompeian red" to almost "carmine" (but duller, especially when old), becoming yellow at the apex and there with a faint network of isodiametric meshes which are formed by decurrent tube-walls and are red, more rarely yellow, occupying a very narrow zone (1)-2-6 mm. from the hymenophore downwards, the remaining main portion of the stipe entirely smooth and macroscopically almost glabrous, but when seen under a lens, the surface usually appears to be formed by minute floccons which, if very dense, make the surface appear uniformly red, and if scattered (near apex), the yellow begins to show through, or the stipe is beset with transverse rows of very minute (though visible to the naked eye) flocculae on yellow ground, the base yellow or white, or with some chrome yellow or orange, rarely with a dark red spot, solid, tapering upwards from a rather thick base, or ventricose and tapering toward both sides, 50-80-(120) x 18-22-(35) mm.; mycelium pale yellow to light yellow. — *Context* yellowish white to "Martius yellow," deeper yellow in the stipe than in the pileus, or uniformly light yellow, unchanging or bluing (moderately rapidly and moderately deeply) on injury but constantly becoming "lemon chrome" or even deeper golden yellow when exposed for a long time, the blue portions becoming green after a while and then isabelline, and if dried deep golden yellow; odor distinctly fetid, of spoiled meat, but not very strong; taste mild.

Spores and other microscopical characters and also the chemical reactions exactly as in the Florida form of var. *typicus*.

Habitat.—In high hammocks on bare ground, on sandy soil, usually gregarious, fruiting from May till October.

Distribution.—From North Carolina to North Florida and west to Alabama.

Material studied.—FLORIDA, ALACHUA CO., *Gainesville*, TYPE of *B. subluridus* which is also the type of *B. miniatoolivaceus* var. *subluridus*, *Murrill, 15869* (FLAS); *15868* (CO-TYPE) (FLAS), *F 18351* (FLAS); *Singer, F 2157* and *F 2157 a* (FH); *F 2746* (FH); Newnan's Lake, *Singer, F 2635* (FH). NORTH CAROLINA, Hillsborough, Aug. 1864, *Curtis* (as *B. satanas*), (FH), (*540*) (FH); JACKSON CO., Whiteside Cove., *Steward and Howell* (det. Coker as *B. luridus*), *12136* (FH). ALABAMA, TYPE of *B. Underwoodii* Peck, most probably this (see observations) (NYS).

This has been called *B. luridus* by Coker & Beers, *B. satanas* by Curtis, but it is not even similar to either of these species. If there were not the Florida form of var. *typicus* which in all regards except the lesser abundance of red pigment (especially on the pores) agrees with var. *subluridus*, one might consider this as a distinct though most closely related species. Further observations are desirable in order to find out whether or not there is anything like a constant character distinguishing the Florida form from the Northern form of var. *typicus*. If so, there could not be any objection to raising var. *subluridus* to the status of a subspecies or an autonomous species, provided that these distinguishing characters are identical in the Florida form of var. *typicus* and in var. *subluridus*. However in this case, a difficult question might arise because of the necessity of making certain that *B. Underwoodii* is actually the same as *B. miniatoolivaceus* var. *subluridus* since as a species, the former has priority. If they would grow together, *B. rubricitrinus* var. *Fairchildianus* and

B. miniatoporus var. *subluridus* would be difficult to distinguish externally but fortunately they do not grow together, but if they did, they would still be distinguishable by the difference in spore size and the covering of the stipe.

19. BOLETUS FLAVISSIMUS (Murr.) Murr., Mycologia 30:525. 1938.

Ceriomyces flavissimus (Murr.) Murr., Mycologia **30**:522. 1938.

Pileus "yellow chrome" to "light cadmium," or between "light cadmium" and "cadmium yellow," with an occasional faint tinge or "raw sienna" at places, lighter toward the margin where it often reaches "pinard yellow" or "amber yellow," positively opaque when young, but not velutinous or only subvelutinous, later becoming shiny in dry weather but not actually viscid when wetted, usually covered with a very fugacious red floccosity which is rarely persistent beyond the earliest stages but has nothing to do with the "claret brown" (*i.e.* deep red) spots and dots that are often found on the surface of old caps, rarely retaining a "jasper rose" tinge on less exposed portions of the pileus (transition toward *B. miniatoolivaceus,* see observations), convex or sometimes convex-umbilicate, with slightly projecting margin, 50-150 mm. broad, most frequently 65-100 mm. — *Hymenophore* between "reed yellow" and "olive yellow," often bluing where wounded, eventually assuming the color of the spore print which is between "citrine drab" and "deep olive,"[10] depressed around the stipe; tubes 10-20 mm. long; pores "citron yellow," "reed yellow," "deep colonial buff," occasionally with a small ring-zone of "light orange yellow" around the margin, sometimes distilling golden, transparent watery drops, usually gray to cinnamon in dried material, eventually reaching the color of old tubes when fresh but frequently bluing when touched, small and not markedly irregular. — *Stipe* "pinard yellow," "Empire yellow," "amber yellow," or an inhomogeneous mixture of several yellow shades, later with "madder brown," "claret brown," "mineral red" base and, higher up, dots and lines of the same color, glabrous or extremely faintly and minutely subflocculose-pruinate (use a lens), smooth or reticulate with a fine concolorous network to a variable extent, unchanging or bluing where touched, dry, solid, ventricose, or bulbous when young, 45-65 x 22-32 mm.; mycelium whitish, sordid white, yellowish white, or light yellow. — *Context* "pinard yellow," at places more whitish where it begins to dry out but turning "light cadmium" to "deep chrome" in old wounds, not so deep yellow in rapidly dried material, bluing moderately strongly and moderately rapidly in most fresh and not too dry or too old specimens immediately after bruising but even in these the bluing is not constant, if present, it reaches "deep Delft blue" or "deep slate blue" in intensity, in the base of the stipe, the context is usually though not constantly red ("dark Indian red," "Hessian brown," "madder brown," "mineral red," or a still deeper red); taste mild; odor agreeable, somewhat of lemon but becoming cumarinous in dried material.

Spores 10.13.5-(21) x 3.5-5-(5.5) μ cylindric, cylindric-fusoid, cylindric-ellipsoid, or inversely clavate (tapering toward the apex), smooth, honey

10 After two years it has become between "deep brownish olive" and "Saccardo's umber."

brown, thin-walled; *basidia e.g.* 32 x 8μ, hyaline or colored, 4-spored, very few 2-spored; *cystidia* 28-43 x 7-18μ, thin-walled but with thicker walls than the tramal hyphae, hyaline or yellowish to melleous, subulate to fusoid, most frequently with an ampullaceous neck; *trama* truly bilateral, of the *Boletus*-type, but its hyphae becoming parallel in old specimens, 3.5-7μ thick.

Chemical reactions.—KOH on surface of pileus, between "mahogany red" and "chestnut" but darker than both of these in the shiny-capped specimens, dirty brown in opaque specimens; on pores, dirty brownish; on context of pileus, dirty pink; on context of stipe, brown; NH_4OH on surface of pileus, somewhat paler (almost negative); on pores, nil; on context, dirty vinaceous to almost negative; $FeSO_4$ on context, olive; formol negative but stimulating the bluing.

Habitat.—Under or near *Quercus virginiana, Q. laurifolia, Q. nigra, Q. laevis* and *Q. Chapmanii,* on grassy, sandy soil, or on the forest soil in high hammock, also in gardens and on lawns, fruiting from June until September.

Distribution.—Florida, gradually more frequent from the north toward the south but not observed in the tropical zone.

Material studied.—FLORIDA, ALACHUA CO., Gainesville, *Singer, F 2507* (FH); *Murrill, F 18660* (FLAS); *Singer F 2610* (FH); *Murrill, F 15858,* TYPE (FLAS); Sugarfoot Hammock, *Singer, F 2507 a* (FH); HIGHLANDS CO., Highlands Hammock State Park, *F. 408 a* (FH); *F 506* (FH); *? F 616* (FH); Sebring, *Singer, F 408* (FH).

Krieger (The Mushroom Handbook, p. 268, 1936) thinks that *B. pseudosulphureus* Kallenbach (*i.e. B. junquilleus*) is a yellow form of *B. miniatoolivaceus.* In fact, he has seen what he calls a specimen of *B. miniatoolivaceus* with entirely yellow pileus at the Boston Mycological Club, and we have seen such forms in Florida. If we substitute the narrow-spored *B. flavissimus* as described above for the broad spored *B. junquilleus,* Krieger's statement certainly makes sense. It is remarkable that Quélet himself (*l.c.*) made a statement reminiscent of, or rather parallel with Krieger's saying that *Dictyopus junquilleus* Quél. "seems to be a form of *discolor* from which it does not differ except by the concolorous pores." Now, *B. discolor* Quél. is unknown to most mycologists and suspected by some to be a form of *B. Queletii* which differs mainly in the color of the pileus. Thus we would have to distinguish

1. A narrow-spored group, all American forms, containing
   a. a species with yellow pileus: *B. flavissimus* Murr.
   b. a species with red (discoloring olive or brown) pileus: *B. miniatoolivaceus.*
   c. as "b" but with red pores: *B. miniatoolivaceus* var. *subluridus.*
2. A broad-spored group, all European forms, containing
   a. a species with yellow pileus: *B. junquilleus.*
   b. a species with yellow pileus but red pores: *B. discolor.*
   c. a brown or red or orange species with reddish pores: *B. Queletii.*

It seems to me that the species under "1" are specifically different from those under "2" though I cannot deny a marked parallelism in variability. As for the yellow forms in each group (1a, 2a), they can hardly be mere color forms of the other forms (1b, 2b), since the color is not the only distinguishing character. In Europe, it would be surprising that Kallenbach who is rather a "combiner" than a needless splitter, would describe a new species (which he thought his *B. pseudosulphureus* was) without even mentioning *B. Queletii*

which he knew very well (as *B. erythropus*), if they were merely color forms. *B. Queletii* lacks the characteristic strigosity formed by the basal tomentum always noted in *B. junquilleus,* and, besides, does not change as strongly as the latter; all this aside from the differences in color of the pileus and the pores. As for the narrow-spored, American group, the forms with yellow and those with red pileus also appear to be different from each other. *B. miniatoolivaceus* with yellow pileus would not necessarily be *B. flavissimus,* and *B. flavissimus* with some red on the cap (such as my *F 2507, F 2610,* and Murrill's *F 18660*) would not necessarily be *B. miniatoolivaceus.* In fact, the best means of distinguishing these species is not the color of the pileus unless this color is so unmistakable as to make further investigation unnecessary. In dubious cases, the best character for those who perceive them, are the different odors of these species, the agreeable odor of *B. flavissimus* and the disagreeable one of *B. miniatoolivaceus.* In order to explain the odor of the latter to a European one may best compare it with that of *B. satanas,* and vice-versa, yet, the odor of the American species is perhaps more variable than that of *B. satanas.* Another distinguishing character between *B. flavissimus* and *B. miniatoolivaceus* is the context of the base of the stipe which is very rarely deep red in the latter species, and very rarely not so in the former. The chemical characters of these species do not seem to be identical, especially the KOH reaction on the surface of the pileus is quite different according to my notes. It may, however, be argued that the reactions of the cuticular layer are largely determined by the presence or absence of certain pigments, or their proportion, and this would, consequently reduce this chemical reaction to a character parallel to the abundance of the red in the pileus. Also, the geographic area of these two plants are too different to assume that they are color variants of the same species.

We therefore conclude that the yellow form of group 1 as well as group 2 are specifically different from the other forms of their respective group. But cannot the yellow species of each group be combined into one species, accounting for the difference in spore shape with the assumption of the existence of geographic races? I do not think they can. The weaker bluing, the occasionally reticulate stipe, the absence of a conspicuous basal tomentum, and the absence, in all my specimens, of the slightest reddish flush on the pores, are in my opinion enough characters to justify the distinction of two entirely autonomous species.

Murrill has recently (Mycologia **36**:122. 1944) revised his opinion concerning *B. flavissimus,* stating that *"Ceriomyces flavissimus = Ceriomyces aureissimus"* I do not think that these two boletes are even very much related. All they have in common is the fact that they are the two bright yellow boletes of Florida. They do, however, appear to be very similar when first seen in the herbarium, or when separated according to the original descriptions or the key of Murrill's. The best distinction lies in the bluing of *B. flavissimus* (if noticeable), the purple-carmine base (if present) and the constantly and strongly different odor of the dried plants. For those who already know these species, the color of the pileus (not as deep yellow and tending towards chestnut rather than pinkish red in *B. auripes* var. *aureissimus*) is sufficient to separate them in the field.

20. BOLETUS AUSTRINUS Sing., Mycologia 37:798. 1945.

Pileus "vinaceous brown" on the margin, "sorghum brown" on the disc, when dried "sorghum brown" on the margin and paler on the disc, strongly tomentose, turning blue when handled, if young and fresh; dry, convex, 38-55 mm. broad. — *Hymenophore* yellow, greenish yellow, deeply depressed around the stipe; tubes moderately to fairly long; pores discolorous, "zinc orange," or some of the protruding tube-walls with "Etruscan red" or "Corinthian red" tips and the rest of the pores concolorous with the tubes, distinctly bluing when touched; spore print apparently olive, but not obtained in thick layer. — *Stipe* yellow at the apex and beset with very minute to rather small flocculose-furfuraceous particles which are purplish brown or "russett vinaceous," farther downwards, these particles are dense enough to completely or nearly cover up the yellow ground color, with a conspicuous, strigose, "Isabella color" or "buffy citrine" basal tomentum, equal or tapering downwards, slightly ventricose with narrowed apex when dried, 38-40 x 10-12 mm.; mycelium yellowish, sparse at the base. — *Context* yellow, turning blue immediately at the slightest injury in all parts; odor not remarkable; taste mild.

Spores 9.5-12.2 x 4.2-5.5μ, mostly 11-12 x 4.8-5μ, well colored, melleous or brownish melleous, smooth, ellipsoid-subfusoid, with suprahilar depression or without it (mostly with depression); *basidia* about 31μ long and 9.8-12μ broad, 4-spored; *cystidia* at pores 36-41 x 5.3-7.5μ, hyaline or melleous, fusoid with acuminate mucro, or with ampullaceous neck; in tubes much more scattered, mostly basidiomorphous but versiform, strongly incrusted by a melleous incrustation, rarely without it, *e.g.* 29 x 15.5μ; *trama* truly bilateral, of the *Boletus*-type.

Chemical reactions not studied.

Habitat.—Under *Quercus virginiana* in comparatively open places, lawns, etc., on calcareous soil, fruiting in September and October, solitary.

Distribution.—Tropical Florida.

Material studied.—FLORIDA, DADE CO., Matheson Hammock, *Singer, F 753 a*, TYPE (FH); *F 1012*, CO-TYPE (FH).

This species is best determined by the color of the fresh and the dried carpophores. In dried condition it reminds one strongly of *B. tomentipes* Earle which has the basal tomentum still more strongly developed, and its color in fresh condition is described somewhat differently; its size is larger, and the spores are slightly broader than in our Florida species. Notwithstanding all these differences, *B. austrinus* is no doubt the closest relative of *B. tomentipes* among the *Luridi*.

21. BOLETUS HYPOCARYCINUS Sing., Mycologia 37:798. 1945.

Pileus "Saccardo's umber" to "bister," margin somewhat "cinnamon brown," in dried condition olive brown, disitnctly tomentose, pulvinate, about 80 mm broad. — *Hymenophore* yellow, not or slightly depressed around the stipe; tubes moderately long; pores concolorous at the very margin, elsewhere discolorous, red ("hydrangea red" to "mineral red"), very minute. — *Stipe* minutely "carmine" to "acajou red" punctate and lined or striate but not

reticulate, on whitish ground, only the very apex is yellow at places but the base is entirely red ("carmine" to "acajou red"), not distinctly tomentose, very bulbous-difform, about 85 x 52 mm.; mycelium whitish. — *Context* yellowish in the pileus as well as in the stipe, bluing readily when wounded; odor none noticed; taste mild.

Spores 8.5-11.5 x 3.5-3.8μ, subfusoid-subellipsoid, smooth, melleous; *basidia* about 30 x 8μ, 4-spored; *cystidia* 28-38 x 4.5-7μ, with a thin, melleous resinous incrustation, fusoid or almost so, moderately frequent at the pores, scattered elsewhere; *trama* of the hymenophore truly bilateral, of the *Boletus*-type, the mediostratum strongly colored melleous, of axillarly arranged subparallel - subinterwoven, densely packed hyphae, the lateral stratum of completely hyaline, somewhat thicker, loosely arranged and strongly divergent hyphae; *cuticle* of the pileus consisting of strongly interwoven, irregularly interlaced brownish melleous to brown hyphae, the terminal members most frequently clavate, also cylindric and broadly rounded or fusoid with obtuse tips, strongly incrusted by a melleous-brown resinous incrustation; the *red ornamentations* of the stipe consisting of fascicles of hymenially arranged claviculae each of which is deep melleous (in NH_4OH) and 22-30 x 5-8.5μ, in the whitish areas there are corresponding club shaped elements which, however, are hyaline; all *hyphae* without clamp connections.

Chemical reactions not studied.

Habitat.—Under *Quercus virginiana* on the ground. Fruiting in May, solitary.

Distribution.—Known with certainty only from the type locality.

Material studied.—FLORIDA, ALACHUA CO., near Newnan's Lake, May 23, 1943, *Murrill*, (as *B. luridus*), *F 2071*, TYPE, (FH).

Dr. Murrill was kind enough to forward to me for further study this collection of what turns out to be a rare plant in Alachua Co. It is part of the complex he calls *B. luridus*, and according to the herbarium, *B. subvelutipes* and *B. Frostii* ssp. *floridanus* represent the other constituents of this collective species. I would not be surprised if *B. luridus sensu* Coker & Beers which for the most part is *B. miniatoolivaceus* var. *subluridus* contained, as an additional element *B. hypocarycinus*. Though not entirely corresponding to my description, the fungus depicted in Coker & Beers, pl. 3, *fig. 5*, may yet turn out to be this species in a more advanced stage. My material is rather young.

B. hypocarycinus differs from *B. miniatoolivaceus* var. *subluridus* in the color of the pileus which is *never* red nor yellow, and the ground color of the stipe which is whitish at least in youth.

22. BOLETUS SUBVELUTIPES Peck, Rep. N. Y. State Mus. 2(8):142. 1889.

Suillus subvelutipes Kuntze, Rev. Gen. Pl. 3(2):536. 1898.

Pileus "Dresden brown," "snuff brown," "raw umber," "Saccardo's umber," between "Verona brown" and "Argus brown," "Isabella color," between "ochraceous tawny" and "raw sienna," "Sudan brown," "Brussells brown," sometimes with some yellow lights in the dark brown surface ("yellow ocher" or even "light cadmium"), becoming "bister" or darker than the above browns

in age, especially in the center, or with an olivaceous hue ("tawny olive") on the margin, or merely paler towards the margin, subglabrous to somewhat tomentose-velutinous but glabrescent with age, dry but usually sticky-subviscid in rainy weather, pulvinate, becoming flattened and usually also irregular with age, 37-144 mm. broad, rarely up to 160 mm. — *Hymenophore* yellow (except for the discolorous pores), in age greenish yellow, rapidly and intensely bluing on injury, convex beneath, depressed around the stipe; tubes long (8-22 mm.); pores "vinaceous rufous" or "mahogany red," more rarely in youth or in age the yellow of the tubes showing through and the pore surface merely speckled with red, bluing when touched, small; spore print olive. — *Stipe* yellow (any shade between "maize yellow" and "light cadmium," or "baryta yellow" and "pinard yellow," much paler yellow below and also more sordid towards the base, or sometimes tinged with olivaceous, beset with fine reddish or ochraceous cinnamon flocculose specks or horizontally elongated striae which in youth are hardly visible except with a lens but becoming larger with age and then form a distinct floccolose-squamulose covering that in the lower part of the stipe often obscures the ground color, the very base "Etruscan red" or more frequently "haematite red," the color of the covering being the same as that of the pores in the upper part of the stipe, or more rarely between "Hay's russet" and "English red," dry, solid, the base with a mostly red strigose-velutinous basal tomentum in the color of the base ("Etruscan red," "haematite red," or with a more cinnamon tinge), this basal tomentum sometimes (in the south very rarely) wanting, stipe equal with attenuate base or bulbous-ventricose when young, later often more stretched-elongate but still very thick, 33-78 x 12-30 mm.; mycelium creamy pallid-sordid, or whitish. — *Context* entirely deep and rich yellow when young and fresh, less deep and rich and occasionally bleaching to yellowish white in the pileus when older and drier, bluing instantaneously to a deep indigo when bruised and even the surfaces bluing on pressure when young and fresh, concolorous or deep red ("haematite red") in the base, yellow on the plane of attachment of the tubes to the flesh of the pileus; odor faint, agreeable; taste mild.

Spores 11-16.5 x 4.5-6.2μ (northern specimens often with slightly larger spores, *e.g.* 13-17.8 x 4.5-6.5μ, most frequently 13.5-16 8 x 4.8-5.8μ[11]), from as narrow as 16 x 4.8μ to as broad as 11 x 6μ but the vast majority decidedly more than twice as long as broad (Q=2.3 or more in an average), definitely fusoid, with or without a suprahilar depression, smooth, with moderately thin walls and well colored when mature, rusty melleous; *basidia* 23-32 x 8.2-9.8μ, 4-spored, hyaline, usually rather broad in their lower portion and not always clavate; *cystidia* 30-50 x (4.8)-6.8-8.5μ, hyaline, definitely fusoid with narrowly conical mucro, very few of a different shape, rather numerous on the pores,

11 It is not so much the specimens collected in the plains as the specimens from the White Mountains that show the larger spore-measurements. This does not mean that they are different since it corresponds to the rule first indicated by R. Heim on the basis of Alpine material compared with collections from the environs of Paris, and later corroborated by the writer on the basis of specimens from the Pyrenees, likewise compared with Paris specimens, asserting that montane forms tend to have larger spores than the form found in the plains without being otherwise different. Some species, however, do not seem to be capable of this kind of variation in spore volume.

more scattered in the tubes; *cheilocystidia* on the pores only, 17-32 x 4-5.5-(6) μ, cylindric or fusoid or subulate, pale melleous or fulvous-castaneous incrusted, often wavy-flexuous and very crowded where the red of the pores is concentrated; *trama* of the hymenophore truly bilateral, of the *Boletus*-type, slightly colored and denser in the axillar mediostratum, with entirely divergent hyphae with less crowded septa in the lateral stratum; *floccons* of the stipe consisting of a hymenium (on a bilateral hyphal base) formed by basidioles which either remain indefinitely sterile (dermatopseudoparaphyses), or become fertile with two or more rarely four spores, often thinnest in the middle, or fusoid, often melleous, interrupted by dermatocystidia corresponding in character to the cystidia of the hymenophoral cystidia, or sometimes like the cheilocystidia; *basal tomentum* consisting of hyphae that are deep red even when taken from dried material in an ammoniacal medium, strongly interwoven and irregularly arranged but at places, where transition to the floccons of the stipe begins, it is covered by a palisade of versiform, mostly more or less clavate elements with many septa and (as in the other hyphae of this part of the fruit bodies) with moderately thick (0.3-0.5μ) walls; all *hyphae* without clamp connections.

Chemical reactions not studied.

Habitat.—Under laurel oak and live oak (*Quercus laurifolia* and *Q. virginiana*) in high hammocks, on shaded lawns and in well watered gardens, usually in large groups on the ground, fruiting from May until fall; in the north under or near *Quercus, Fagus, Betula,* and *Tsuga* in preferably mixed woods from July till September.

Distribution.—New England to Florida (not reaching the tropical zone), western limits unknown.

Material studied.—FLORIDA, ALACHUA CO., Gainesville, *Singer, F 1895, F 1895 a, F 1895 b,* and *F 1895 c,* also several unnumbered collections (FH); *F 2081* (FH). MAINE, Georgetown, *H. Webster* (det. E. B. Blackford as *B. luridus*), (FH). NEW HAMPSHIRE, Shelburne, *Farlow,* Sept. 1891 and Sept. 1893 (FH); Chocorua, *Linder & Singer* (FH). MASSACHUSETTS, Newton, *Darker, 5635* (det. Linder as *B. luridus*), (FH); Woods Hall, Farlow (FH); Arnold Arboretum, Jamaica Plain, *Darker* (det. Linder), *6155* (FH); Harvard, *Singer & Harrie Dadmun* (det. Singer), (FH); Wakefield, *Singer, M 105* (FH).

Forma **glabripes** f.n.

Stipite glabro, flocculis destituto, flavello a typo differt. Cum typo.

This differs only by the lack of the flocculose-squamulose covering of the stipe which is completely glabrous and yellowish, except for the red velvety basal tomentum. The spores are paler and smaller, and also fewer than in the type form but the specimens are parasitized, and though apparently mature, not as fertile as normal specimens. It is not impossible that this is a partially sterile teratologic form since failure to form the hymenia of the stipe would cause the morphological result observed here. The forma was found together with the type at Gainesville, Fla., *Singer F 2169* (FH).

B. subvelutipes Peck is, of all species treated here as occurring in Florida, most closely related to *B. hypocarycinus* Sing. The latter should be compared with *B. subvelutipes* f. *glabripes* Sing. which differs in the velvety basal tomen-

tum and the complete absence of any kind of marks on the yellowish, not whitish stipe. The spores are very similar in *B. subvelutipes* f. *glabripes* and *B. hypocarycinus,* at least in the specimens available.

It may be asked why this is not called *B. erythropus* as it has been called by Burt in *Icones Farlowianae* and as it is called by Snell and has often been determined by Peck. Since there is no doubt as to the identity of *B. subvelutipes* with our American collections, I gave preference to this name and shall continue to do so as long as more convincing and conclusive data on the identity of the American and European *B. erythropus* are not available. The European *B. erythropus* is well known to this writer. It is undoubtedly intimately related to the American species but the following differences (which, of course, may yet turn out to be of secondary importance, or not quite constant in all instances during future observations) have been noted by me: *B. subvelutipes* has the characteristic red basal tomentum which is strigose below and velvety above but which in several of our collections is either replaced by an olivaceous tomentum, or is entirely wanting. The latter two conditions are rarer in the north, and extremely rare in the south. This is exactly reversed in the European species where I have never seen red tomentum on the base, and I cannot find a citation in the literature where it is mentioned. The carpophores of the American form are often more slender, though large specimens are more frequent, but even there the stipe tends to be thinner as can easily be seen when two pictures are compared such as *Icones Farlowianae,* pl. 85 and Kallenbach, *Pilze Mitteleur.,* pl. 30. This comparison also shows a slight difference in the color of the pileus which is more deep reddish brown or deep rusty brown or yellowish-rusty-brown in the American plant with orange to red caps never occurring while in the European type of *B. erythropus* the surface of the pileus is usually a deep dusky brown, and frequently tends to be partly or entirely orange or red. It seems that while the cheilocystidia are the same in both forms, the real cystidia are somewhat different being more acute in the American species. The spores of our southern form are somewhat more variable in shape and smaller in size than those of *B. erythropus* in Europe though the specimens from the White Mts. usually have larger fusoid spores.

23. BOLETUS OLIVEISPORUS (Murr.) Murr., Lloydia 7:326. 1944.

Ceriomyces oliveisporus Murr., Lloydia 7:323. 1944.

Pileus either dark fulvous, tinged with bay (according to Murrill) and then between "cinnamon brown" and "Prout's brown" when dried carefully, or more irregularly colored with the margin in fresh condition "cinnamon buff" and the larger middle zone much darker (between "Prout's brown" and "mummy brown" when fresh) and in these specimens the center tending to become tessellate-areolate in the manner of *Russula virescens,* somewhat tomentose on the margin or entirely finely tomentose, not viscid or at least never strongly so, convex, then more or less applanate, with slightly projecting sterile margin, 60-185 mm. broad. — *Hymenophore* yellowish with a faint greenish tinge, soon about "olive lake," depressed around the stipe, or in smaller specimens not depressed; tubes long (5-20 mm., depending on the size of the carpophores); pores concolorous, bluing readily when touched or in-

jured, small but not "stuffed," 0.3-0.8 mm. wide or somewhat wider but, at least in average, not reaching 1 mm. in diameter; spore print olive. — *Stipe* at the base "Saccardo's umber" to "sepia" and subvelutinous to subglabrous, farther upwards in this same color minutely but distinctly flocculose-punctate on pallid ground and at the very apex more or less yellow and glabrous to subglabrous, in the middle often with a "Corinthian red" belt caused by minute but distinct floccons of this color, never reticulate anywhere, dry, solid, subequal to strongly tapering downwards and the base almost pointed, without red or olive basal felt, often slightly curved, 40-85 x 10-50 mm. (at the apex); mycelium white, inconspicuous. — *Context* yellowish white to yellow in the pileus, deeper yellow in the stipe, bluing instantaneously and strongly to slowly and weakly in the stipe and fairly rapidly and distinctly to not at all in the pileus, often with a dull reddish brownish zone beneath the cuticle of the pileus; odor slight and agreeable; taste mild.

Spores either 11-15 x 4-4.8μ (mostly 12.7-13.7 x 4.3-4.5μ as in the type specimens), or up to 11.5-17 x 4.5-6μ, (mostly 14-15 x 5μ) depending on the size of the carpophores, melleous to rather intensely brownish melleous, with thin to moderately thin smooth walls, fusoid; *basidia* 28-38 x 9.3-11μ, hyaline, more rarely melleous, 4-spored, exceptionally 3- or 2-spored among the normal 4-spored ones; *cystidia* 34-62 x 6.5-10.3μ, with a distinct, melleous granular incrustation, much more rarely without an incrustation, sometimes even fulvous castaneous, sometimes with an adpressed resinous hood, fusoid, mostly with a tapering (upwards), narrowly conical and usually rather long apex whose very tip is subacute or obtusate-rounded (thus recalling the cystidia of *B. subvelutipes*), moderately to very numerous on the pores even in age, rare in the tubes; *cuticle* made up of long, filamentous hyphae without any visible order in the specimens available (mature), deep fulvous brown, incrusted; all *hyphae* without clamp connections.

Chemical reactions.—KOH on surface of pileus (center), negative or on the margin ochraceous brown; on context, ochraceous brown. — NH_4OH and NH_3 on surface of pileus, negative; on context, keeping the bluing down (NH_4OH). — HNO_3 on surface of pileus (center), negative. — $FeSO_4$ on context, dirty greenish.

Habitat.—In flatwoods on stumps of or under *Pinus palustris* (not far from a patch of *Quercus minima* at least at one locality), solitary, in July and August.

Distribution.—North Florida.

Material studied.—FLORIDA, ALACHUA CO., 2 miles west of Gainesville, *Singer, F 2847* (FH); west of Rochelle, *Murrill, F 17961*, part of TYPE (FH)

This interesting species seems to be astoundingly variable in size and to a certain degree also in color and in shape. I had intended to publish on my collection (*F 2847*) as the type of a new species when in the last minute Murrill's description of *B. oliveisporus* appeared and the author received a specimen from the type collection (*F 17961*). This specimen is much smaller than my *F 2847*, and the pileus is more evenly colored, the stipe lacks the reddish belt in the middle, the spores are also somewhat smaller. Nevertheless, the remaining characters are so strikingly in accord (and the specimens still

show them well enough) that it became necessary to consider these collections as identical and describe them under the name proposed by Murrill.

This species may be briefly characterized as similar to *Boletus pulverulentus* from which it differs in several characters including the smaller pores, the somewhat different shape of the cystidia and somewhat broader basidia, the lesser degree and constancy of the bluing and the negative reaction with HNO_3. There may also be a slight difference in the color of the hymenophore but this ought to be checked upon on more material than there is at our disposal. It also differs sharply in the habitat which is very peculiar though several hammock species, *viz.*, *Porphyrellus subflavidus, Xerocomus pseudoboletinus,* and *Leccinum chalybaeum* have been found under similar conditions. *B. oliveisporus* differs from *B. subvelutipes* by the concolorous pores and the absence of basal tomentum, and also by the narrowness and inconstant occurrence of the reddish pustules on the stipe and the habitat. *B. luridellus* is distinguished by the characters indicated in the key.

24. BOLETUS LURIDELLUS (Murr.) Murr., Mycologia 30:525. 1938.

Ceriomyces luridellus Murr., Mycologia **30**:523. 1938.
Ceriomyces subsensibilis Murr., Mycologia **31**:111. 1939.
Boletus subsensibilis Murr., Mycologia **31**:112. 1939.

Pileus "amber brown," "Brussels brown," often in virgate streaks, one color alongside with the other, or on yellow ground, becoming "ochraceous tawny" or "hazel," or "buckthorn brown," and unicolorous in age, also often "cinnamon" and "Mikado brown," and partly discoloring to "tawny olive," or even as dull as "snuff brown" to "Saccardo's umber," sometimes rather pl. 14, J 10 with "sombrero" (M. & P.) giving the general impression of "yellow beige" (M. & P.), occasionally with some "ochraceous tawny," tomentose, or glabrous with subvelutinous margin, mostly glabrescent in age, sometimes minutely rimulose to innately punctate, pulvinate to subflat, often with up to 1 mm. projecting sterile margin, 40-120 mm. broad, rarely broader. — *Hymenophore* "pinard yellow" then "lemon yellow" or "pale lemon yellow," then "primuline yellow" and discolored, especially at the pores by autoxydation and spores, and usually more greenish in age (but not so much on the pores), depressed around the stipe, or adnate without depression; tubes long (10 mm. or longer); pores concolorous, bluing when touched, minute but not closed in fairly young specimens, eventually becoming wider and reaching 1 mm. in diameter which is rather wide for a *Boletus* of this section, but the majority of pores is smaller than 1 mm. (4 pores to 3 mm. in an average); spore print "olive brown." — *Stipe* yellow ("pinard yellow," "picric yellow" to "lemon yellow") at the apex and here almost always showing a narrow reticulate belt in continuation of the pores, or with a "buckthorn brown" reticulation reaching somewhat farther downwards (but not more than about one fourth of the length of the stipe) on yellow ground, beset with "buckthorn brown" flocculose flecks on yellow, yellowish or rarely brownish ground below the reticulation, the base almost uniformly "Vandyke red" or "dark mineral red," or "Hay's russet," or dotted or speckled in these colors, bluing where

touched, dry, solid, equal or ventricose, or tapering downwards with pointed base, 45-95 x 9-30 mm.; mycelium inconspicuous, white or dirty whitish. — *Context* "Martius yellow" to "picric yellow," or becoming paler yellow in the pileus, in the stipe "primuline yellow" marbled with paler yellow, concolorous with the outside in the base, bluing readily and strongly in all parts; odor none, or insignificant; taste mild.

Spores (11.5)-12.5-17.3 x 4.5-5.5μ, fusoid, smooth, rather thin-walled, melleous, with hilar depression but some without it; *basidia* 22-34 x 8.3-12.3μ, 4-spored, very rarely some with 2 or 3 sterigmata; *cystidia* 26-35 x 7.5-10μ, hyaline, ampullaceous (with usually rounded tip), in the tubes and on the pores; *trama* truly bilateral of the *Boletus*-type, the hyphae of the lateral stratum distinctly divergent and looser than those of the silghtly melleous and axillar mediostratum in which some melleous laticiferous vessels are usually found; *cuticle* of pileus composed of cylindric, interwoven and interlaced hyphae with the terminal members not parallel but all at the very surface, clavate, brownish melleous; all *hyphae* without clamp connections.

Chemical reactions.—KOH on surface of pileus, much deeper brown; on context, ferruginous-ochraceous. — NH_4OH on margin of pileus, lilac; on context and on surface of stipe, olive; on pores, negative. — HNO_3 on surface of pileus, reddish brown becoming brown; on context, pale ochraceous or rusty ochraceous. — Formol on context, more blue, becoming bluish sordid after a while. — $FeSO_4$ almost negative but if KOH is added afterwards, a brown reaction is obtained.

Habitat.—On open and shaded lawns, in high and mesophytic hammocks, never very far from either *Pinus palustris* or *P. australis*, or more often *Quercus Chapmanii, Q. geminata, Q. laurifolia, Q. virginiana*, etc. on the ground, usually in rather large to very large groups, sometimes even cespitose, fruiting from May until October.

Distribution.—Florida, from North Florida to South Florida but not in the tropical zone.

Material studied.—FLORIDA, ALACHUA CO., Gainesville, *Murrill F 15863*, TYPE of *B. luridellus* (FLAS); TYPE of *B. subsensibilis* (FLAS); AUTHENTIC material of *B. subsensibilis* (FH); *Singer F 1999, F 1999 a, F 1999 b* (FH); *F 2152* (FH); *F 2161* (FH); Dayville southwest of Gainesville, *Singer, F 2476, F 2476 a* (FH); also other collections from Alachua Co. by Murrill and Singer; HIGHLANDS CO., Highlands Hammock State Park, *Singer, F 598* (FH); *F 615* (FH); *Singer & Altvater, F 546* (FH).

This species is somewhat similar to the European *B. appendiculatus* Schaeff. *ex* Fr. in some forms, especially the form depicted in Kallenbach, Pilze Mitteleuropas *1*, pl. 31. But, of course, these species are not closely related.

B. luridellus has been well described and is abundantly represented in the Herbarium at Gainesville under the name of *B. subsensibilis*. Murrill himself is not inclined to consider *B. luridellus* and *B. subsensibilis* as the same species. However, the type specimen of *B. luridellus* has been compared carefully by the writer, and the only conclusion one can arrive at is that they are identical. The spores of the type are slightly smaller than in the average specimen of *B. subsensibilis* but this alone would hardly be sufficient for a separation. Unfortunately, the species much less completely described by its own author

and found only once by him, *B. luridellus*, has the priority over *B. subsensibilis*, and we are thus forced to use the earlier name.

One may be tempted to consider *B. luridellus* as described above, as a brown variety of *B. rubricitrinus* Murr. However, after prolonged observation of several hundreds of specimens under varying conditions and in different counties, I have firmly convinced myself that they are different species. They are constant in their colors; never has the slightest transition been observed, and the reticulate apex, though not quite constant in *B. luridellus*, is *constantly* absent in *B. rubricitrinus*. The latter species is still rather frequent in the tropical lime soil zone of South Florida where *B. luridellus* is not represented.

25. BOLETUS RUBRICITRINUS (Murr.) Murr., Bull. Torr. Bot. Cl. 67:66. 1940.

Ceriomyces rubricitrinus Murr., Bull. Torr. Bot. **67**:66. 1940.

Var. TYPICUS

Pileus "ocher red," "Japan rose," also "terra cotta," "testaceous," "cacao brown," "buff pink," "Etruscan red," "orange cinnamon," or some of these colors mixed, under dry conditions remaining so or discoloring with age (see below), under wet weather conditions soon becoming deeper colored, rarely so from the beginning, *i.e.* "vinaceous rufous," "Pompeian red," or "madder brown" in dots, or entirely "madder brown" all over, or only the disc "madder brown," the extreme margin sometimes "light salmon orange," the color of the pileus often eventually fading to "tawny olive," "buckthorn brown," "clay color," or the red portion reduced to make space for some "baryta yellow," to "pinard yellow" intermixed spots, especially near the margin, bluing where touched if very fresh and young, soon becoming unchanging, glabrous to subtomentose, feels like kid, non-viscid, rarely partially tomentose to rimose, pulvinate, eventually almost flat, the center sometimes somewhat depressed, (30)-40-150 mm. broad. — *Hymenophore* between "pinard yellow" and "picric yellow," then becoming "wax yellow" and finally "pyrite yellow" or "citron green," bluing when touched, especially when young, depressed around the stipe, often deeply so; tubes rather long; pores concolorous, irregular in shape, level, and diameter, small and punctiform when young with some medium sized ones intermixed when mature, most of them decidedly below 1 mm. on diameter, but in large mature specimens there are always a few reaching 1 mm., angular when mature; spore print "olive brown." — *Stipe* "Martius yellow," "pinard yellow," "mustard yellow," "primuline yellow," later often more "Empire yellow" or "light cadmium," sometimes with an olive gray zone in the middle, lower half or the base only with many red spots or dots ("madder brown," "Hessian brown," "burnt lake"), coarsely and indistinctly fibrosely longitudinally striate or rugulose, not reticulate except for a very narrow (1-2 mm.) zone at the very apex of the stipe where occasionally a very faint reticulation continues the pores downward *i.e.* spuriously reticulated, the whole surface or most of it beset with "Pompeian red" to "madder brown" or concolorous (yellow), mostly the former, squamulose floccons comparable with those of *B. subvelutipes*, or with somewhat finer punctiform, furfuraceous particles of

the same colors which may sometimes be difficult to observe if no lens is used, but in most cases the covering clearly visible to the naked eye, solid, dry, tapering upwards or downwards, or ventricose, more rarely subventricose-subequal, or becoming so with age, (35)-50-120 x 15-37 mm., mostly 18-28 mm. thick; mycelium whitish to pale ochraceous or salmon ochraceous, often variegate in these colors. — *Context* yellow, in dry weather sometimes pale yellow, bluing when bruised, with much deep red ("madder brown," "Hessian brown," "burnt lake") in the base, soft except for the base; odor none; taste mild.

Spores 12.5-18.8-(19.7) x (4.5)-4.8-7.7μ, mostly (14)-15-(17) x 5-5.5μ, melleous or brownish melelous, smooth, subfusoid-ellipsoid or subcylindric to fusoid, with distinct or indistinct suprahilar depression, occasionally with a depression on the external long side, with thin to medium walls; *basidia* 26-39 x 9-12μ, 4-spored; *cystidia* 37-53 x 5-7.7μ, fusoid and subacute or fusoid with ampullaceous neck, hyaline, numerous at the pores, but scattered in the tubes; *trama* truly bilateral of the *Boletus*-type; all *hyphae* without clamp connections.

Chemical reactions.—KOH on surface of pileus, deep maroon, or between "raw sienna" and "orange citrine," or "Sudan brown"; on surface of stipe, "amber brown"; on context from negative over light brown to rich brownish yellow (depending on the degree of autoxydation that has been allowed to take place before application of the reagent); on pores and tubes, usually brown. — NH_4OH on surface of pileus, from olive or dirty olive (near "buffy citrine") to almost negative; on surface of stipe, brown; on context, usually more bluing when moist enough, or only somewhat sordid otherwise. — HNO_3 on surface of pileus negative. — HCl on surface of pileus negative; on surface of stipe the floccons brigher red.

Habitat.—Under pines (*Pinus australis, P. caribaea*, rarely *P. palustris*) and under oaks (*Quercus laurifolia, Q. virginiana*) on the ground, preferring roadsides, especially where both pines and oaks are present, solitary or more often gregarious. Fruiting from May till November.

Distribution.—Apparently in all counties, at least in all zones of Florida.

Material studied.—FLORIDA, ALACHUA CO., TYPE (FLAS), and AUTHENTIC material (FLAS); also *F 19593* (as *B. subsensibilis*) (FLAS); Gainesville, *Singer, F 2123* and *F 2123 a* (FH) and other collection from in and around Gainesville; HIGHLANDS CO., Highlands Hammock State Park, *Singer, F 181 a* (FH); DADE CO., Fairchild Tropical Garden and Matheson Hammock (not in the densest growth), *Singer, F 753* (FH); F *917* (FH); *F 1369* (FH); Coral Gables, *Singer, F 1396* (FH).

Var. FAIRCHILDIANUS Sing., Mycologia 37:798. 1945.

Differs in having "Pompeian red" pore mouths on "primuline yellow" ground; the pileus of this collection was between "vinaceous rufous" and "dragon's blood red"; the stipe all the way from "wax yellow" to "massicot yellow" with "Pompeian red" floccons; context yellow, strongly bluing. Chemical and anatomical characters as in the type variety. Under *Quercus virginiana*, October 31, 1942, *Singer F 1368* (FH).

This beautiful species is common in Florida during the summer season and can easily be recognized in most cases. However, one may find it difficult, at

times, readily to distinguish this from *B. rubellus* ssp. *caribaeus* Sing. in Dade Co. since they often grow in neighboring localities. The present species is less tomentose, the red in the base is more striking and more constant, and the pores are slightly smaller in an average. In the laboratory, the distinction, in practically all cases, is easy because of the marked difference in spore size. This species is not closest to *B. rubellus* but to *B. dichrous* Ellis and *B. luridellus* Murr. The former, if it represents a separate species, would be distinguished by the viscose pileus, the latter is distinguished by the color of the pileus and the reticulation on top of the stipe.

26. BOLETUS FROSTII Russell *apud* Frost, Bull. Buff. Soc. Nat. Sc. 2:102. 1874.

Boletus alveolatus Berk. & Curt. *apud* Frost, Bull. Buff. Soc. Nat. Sc. **2**:102. 1874.
Suillus Frostii Kuntze, Rev. Gen. Pl. **3**(2):535. 1898.
Suillellus Frostii Murr., Mycologia **1**:17. 1909.

Ssp. TYPICUS (not observed in Florida but described here for comparison).

Pileus "jasper red," "nopal red," "carmine" in fresh condition, if dried properly between "acajou red" and "Pompeian red" in the herbarium, with or without a tinge of "Morocco red," occasionally showing some yellow on the margin, strongly viscid when wet, subglabrous, rarely subtomentose, subpruinose at places when dry, strongly shining when dry if it has dried out after rains, convex to plane, 55-155 mm. broad. — *Hymenophore* yellowish, later more greenish yellow, bluing on injury, with the pore-mouths discolorous, depressed around the stipe; tubes (6)-7-9-(12) mm. long; pores "acajou red," bluing on pressure, minute, 12-14 to 5 mm.; spore print olive brown. — *Stipe* "acajou red," in dried condition between "Vandyke red" and "mineral red," occasionally with some yellow showing especially at the apex when old and on the base, strongly alveolate-reticulate over a considerable length, often almost to the base, the reticulate ridges "acajou red" on concolorous, rarely partly yellow ground, not viscid or with a waxy-subviscid touch, solid, straight or with curved base, variable in size and shape, usually tapering upwards, also subventricose, etc., 45-110 x 18-25 mm, at base; mycelium yellowish white to light yellow. — *Context* whitish yellow to yellow, somewhat marbled in the stipe, more or less bluing when injured, sometimes reaching a deep blue shade almost immediately, in other carpophores bluing weakly and slowly, old injuries reddened; odor almost none; taste mild.

Spores and other microscopical characters as in ssp. *floridanus*.

Chemical reactions.—KOH on surface of pileus, tan color; on pores, cinnamon; on context, tan color. — NH_3 on surface of pileus, negative; on pores, little reaction; on context, either augmenting the bluing or negative. — NH_4OH not much stronger reaction than with NH_3-vapors. — $FeSO_4$ with context almost negative, keeps deep yellow portions from bluing.

Habitat.—In oak woods, especially on somewhat hilly ground in moderately dense forests. Fruiting from June till October.

Distribution.—From Maine to Georgia and west to Michigan and Tennessee.

Material studied.—VERMONT, Brattleboro, AUTHENTIC material, probably part of TYPE, C. C. *Frost* (FH). MASSACHUSETTS, Newton, *Farlow* (FH); Chelmsford, *Mrs. Isadore Albertini* (det. Linder) (FH); Canton, three collections by *D. H. Linder* (FH); Arlington, *Singer;* Woburn, *W. L. White* (det. Singer) (FH). RHODE ISLAND, East Providence, three collections by W. G. Farlow (FH). NEW JERSEY, *Ellis,* July 30, 1875 (FH). NORTH CAROLINA, Hillsborough, Curtis (as *B. purpureus*) (FH). GEORGIA, Thompson, area of the Fall line Sandhills, *Bartlett* (det. Farlow), *1571* (FH). MICHIGAN, Ann Arbor, Aug. 18, 1932, *A. H. Smith* (FH, a similar collection in LE).

Subspecies FLORIDANUS Sing., Mycologia 37:799. 1945.

Pileus "Corinthian red," "light Corinthian red," with spots or larger areas of "mineral red" or even "dark mineral red," "madder brown," or prevalently a mixture of "'orange vinaceous," "jasper red," "acajou red" with occasionally more orange or yellow on the margin, the dried pileus usually about "mineral red" with some "Etruscan red," or "hydrangea red" with some "light russet vinaceous," opaque or slightly shining when dried, distinctly viscid after prolonged rains but ordinarily not very strongly red and rapidly drying and becoming opaque in drier weather, consequently usually seen in dry condition, tomentose or velutinous, or partly tomentose and partly subtomentose (not merely subtomentose-subpruinate), somewhat rimulose at times, pulvinate, soon with applanate or even subdepressed center, or remaining convex everywhere, 50-100 mm. broad. — *Hymenophore* yellow, with discolorous pores, soon more or less depressed around the stipe; tubes 6-9 mm. long; pores "Corinthian red" or a similar color or blotched or punctate in this color on yellow ground, rarely entirely yellow in young stages and reddening gradually while maturing, again becoming concolorous with the tubes (olive) in very old or in dried material, strongly to moderately strongly bluing when touched, about 0.5 mm. wide. — *Stipe* "deep vinaceous," "dark vinaceous," "Indian red," "Etruscan red," "vinaceous," "old rose," "acajou red," "neutral red," either unicolorously red, with the deeper red colors usually rather concentrated near the base, or with a strong (but not stronger than in *B. luridus*) venose (not lamellose) reticulation in the above-indicated colors on pinkish-pallid, light pink, or yellow ground but the yellow ground never extending from the apex to more than one third of the stipe's length, the meshes distinctly elongated longitudinally [(0.5)-1.5-3.5 x 0.5-1.0 mm.], covering more than the upper half of the stipe and often practically its entire length, dry or subviscid-slippery when wet, solid, subequal or tapering upwards, or fusoid-ventricose with the thickest portion usually just below the middle, 40-80 x 17-27 mm.; mycelium pale yellow. — *Context* pale yellow, or light bright yellow, or whitish, sordid olive or sometimes pale reddish in the base of the stipe but never deep red in any part, usually strongly bluing everywhere when wounded; odor slight, not disagreeable; taste mild or slightly acidulous.

Spores 13.2-16.7-(18) x (4)-4.5-5.3μ, melleous to brown, ellipsoid-fusoid, smooth; *basidia* 26-35 x (6.5)-10.5-11.5μ, 4-spored; *cystidia* 30-53 x 7.5-14μ, fusoid or subampullaceous, hyaline, thin- or thick-walled, numerous, especially on the pores, the tip mostly rounded; *trama* bilateral of the *Boletus*-type though the difference between the density and the color of the two strata appears to be moderately striking, the hyphae of the lateral stratum strongly and entirely

divergent; *cuticle* consisting of interwoven hyphae and some laticiferous vessels, the terminal members of the chains of hyphae versiform and often assuming the shape of dermatocystidia but not arranged in a palisade nor constantly erect; all *hyphae* without clamp connections.

Chemical reactions similar to those of the typical subspecies.

Habitat.—In open stands of oak, mostly on shaded lawns or around scrub areas, under or near *Quercus Chapmanii, Q. laurifolia, Q. virginiana,* and probably also other species of *Quercus,* on grassy or naked sandy soil, usually in large groups, fruiting from May until October.

Distribution.—Florida (but not in the tropical zone).

Material studied.—FLORIDA, HIGHLANDS CO., Highlands Hammock State Park, *Singer F 616* (FH); *F 650* (FH), *F 654* (FH); *F 657A* (FH); ALACHUA CO., Gainesville, *Erdman West,* July 1935 (det. Murrill as *B. luridus*), (FLAS); *Singer, F 2204* (FH); *F 2428* TYPE of the subspecies (FH); *F 2503* (FH).

The Florida material differs from the typical plant in two characters, *viz.,* in the color of the pileus and in the degree of its feltiness, and also slightly in the venose, not lamellose reticulation of the stipe. In some very rare cases we have observed single carpophores in Florida that showed the strong alveolate-reticulate stipe of the type subspecies, but they had it only on one side, on the other side of the stipe the reticulation was exactly as in *B. luridus.* The degree of viscidity is rather hard to express more definitely, and the degree of tomentose covering also is hard to define but the color of the pileus can easily be checked against Ridgway. In very rare instances have we found pilei which show partly the colors characteristic for the opposite subspecies, and in these cases the sum of characters has to decide. For all practical purposes, however, excepting perhaps the determination of specimens collected along the borderline between the two subspecies, the distinction can be made automatically according to the area of origin. The external appearance of typical material in the north on the one hand and in Florida on the other hand, is sufficiently different to explain the fact that Dr. Murrill consistently and correctly determined all northern material as *B. Frostii* while he determined all Floridan material just as consistently as *B. luridus.*

Extralimital Species

BOLETUS IMPOLITUS Fr., Epicr., p. 421. 1838.

A good species but often misunderstood, not yet observed with sufficient certainly in North America but collected by the writer in Austria and in the Ukraine (U.S.S.R.), generally corresponding to the figures given by Kallenbach, Pilze Mitteleur. **1**, pl. 4, *figs. 1-11.*

BOLETUS QUELETII Schulz., Hedwigia **24**:143. 1885.

Boletus purpureus Secr., Mycogr. Suisse **3**:29. 1833 (*an* Pers. 1825).
Boletus erythropus Pers. (1796) *ex* Kallenbach, Pilze Mitteleur. **1**:21. 1927, *non* Pers. 1825.
Boletus lateritius Bres. & Schulz. *apud* Schulz., Hedwigia **24**:143. 1885.
Boletus Bresadolae Schulz., Hedwigia **24**:144. 1885, *non* Quélet.
Boletus slavonicus Sacc. & Cub., Syll. **6**:17. 1888.
Boletus Queletii var. *rubicundus* R. Maire, Bull. Soc. Myc. Fr; **26**:195. 1910.
?*Boletus Schulzeri* Quél. *apud* Schulz., Hedwigia **24**:143. 1885.

The spores of this European species (probably also occurring in parts of Asia, and certainly in North Africa) are usually about 13-13.7 x 6.5-6.8μ, some up to 16 x 8μ, and a minority narrower (10-14 x 4.8-6.5μ), ellipsoid in frontal view, subellipsoid in lateral view, without suprahilar depression but constantly with a suprahilar applanation, melleous, smooth. These spores are rather characteristic as pointed out by Kallenbach, *l.c.* but that author has not seen material of Buchholz called *B. erythropus*, "siniak" (Russian common name) or else he would have cited it as occurring in U.S.R.R. instead of citing Buchholtz's indication for *B. miniatoporus* Secr. (*i.e.* the real *B. erythropus*). Buchholtz's specimens from his Herbarium *499* (FH) belong to *B. Queletii*.

BOLETUS DUPAINII Boud., Bull. Soc. Myc. Fr. **18**:139. 1902.

I have had excellent fresh material from the late Dr. Codina of La Sellera, Catalonia, Spain. The pileus is much more viscid and a much purer and deeper red or pinkish red than *B. Queletii* ever attains. I think that Kallenbach is mistaken considering it as a form of the latter. While studying our Florida species I was much more concerned about its possible identity with American species such as *B. miniatoolivaceus* var. *subluridus* (Murr.) Sing. which it resembles to a certain degree. But the much more viscid pileus and broader spores, and probably a slightly different range of colors, and the lack of odor distinguish the European species sufficiently. In Europe it has a definitely southern distribution and is known thus far from France, Spain, and Switzerland.

BOLETUS JUNQUILLEUS (Quél.) Boud., Icon. Mycol. **4**:76. 1905-1910.

Dictyopus junquilleus Quél., Assoc. fr. avanc. sc. **1897**:450. 1898.
Boletus pseudosulphureus Kallenbach, Zeitschr. Pilzk. **2**:255. 1923.

We consider this European species as independent so long as it cannot be proved that *B. discolor* Quél. (which has priority) is actually a form of the same species. This is what Quélet seemed to think, but why, then did he describe the two species separately? This species is closest to but different from *B. Queletii* Schulz. among the European and *B. flavissimus* Murr. among the American species.

BOLETUS TOMENTIPES Earle, Bull. N. Y. Bot. Gard. **3**:298. 1904.

Ceriomyces tomentipes Murr., Mycologia **1**:154. 1909.

If this species is correctly described macroscopically, it would be outstanding in having the hymenophore becoming brick red when wounded or on drying. However, the type specimens distributed by Earle and studied by us (FH, NY) are strikingly similar to *B. austrinus* Sing. and we think that they belong in the same "stirps." It would be worth while to try to re-collect this species at the type locality (Stanford University, among decaying oak leaves, Calif.) and see whether the hymenophore actually turns red on injury, or merely becomes red during its individual development as is the case in many species of the *Luridi*.

BOLETUS VERMICULOSUS Peck, Ann. Rep. N. Y. State Mus. 23:130. 1872.

This Eastern species (New England to North Carolina) is remarkable for its small, often rather slender carpophores and the color of its stipe and pores. Microscopically, we did not find anything extraordinary for this section in Peck's material (NYS) and specimens collected by Farlow (FH). The spores are rather small and not deeply colored, melleous, cylindric-subfusoid, or ellipsoid-oblong with or without suprahilar depression, sometimes the whole interior long side depressed, variable in shape and size, 8.7-13.3 x 3-4.2μ. These spores distinguish *B. vermiculosus* from forms of *B. subvelutipes* in which the pores or the stipe are more brownish colored than usual, and also from all similar species occurring in Europe. *B. miniatoolivaceus* var. *subluridus* has constantly bright red, never brown pores and stipe and differs also in the color of the pileus. This species has been well described and illustrated by Coker & Beers, Bolet. N. Carol., p. 40. 1943. It has not been observed in Florida.

BOLETUS LURIDUS Schaeff. *ex* Fr., Syst. Mycol. 1:391. 1821.

Leccinum luridum S. F. Gray, Nat. Arr. Brit. Pl. 1:648. 1821.

The writer has studied this species which is not uncommon in most of Europe, North Africa and parts of Asia, but has never seen it in North America, notwithstanding the claims of practically all American authors. Even Kallenbach indicates North America as part of its geographic area, citing L. C. C. Krieger. Krieger, however, does not even give an original description of *B. luridus* in his latest book (The Mushroom Handbook, p. 265. 1936). Material received from the University of North Carolina proves that Coker and his school determine as *B. luridus* what actually appears to be *B. miniatoolivaceus* var. *subluridus* (possibly including various other species of section *Luridi*), while the *B. luridus* in the sense of Murrill (1942) is *B. Frostii* ssp. *floridanus* (also including other representatives of the section *Luridi*). The *B. luridus* of Curtis and probably also of Schweinitz is *B. Frostii* ssp. *typicus* (*Sprague, 253,* FH). *B. subvelutipes* also is seen to be called *B. luridus* by some authors.

The writer has been seriously poisoned by the true *B. luridus* in Austria and it may be supposed that the content of poisonous matter in the fruit bodies varies from negligible to considerable, or else we would have to assume that *B. luridus* consists of at least two physiological races. It is irresponsible and dangerous for the amateur stubbornly to insist on the harmlessness of the European *B. luridus,* and so long as it is not proved that all the American species confused with it are harmless and that the true *B. luridus* does not occur in any part of North America, it would be wise to caution people in this country not to experiment with any representative of the section *Luridi.*

BOLETUS RHODOXANTHUS (Krombh.) Kallenbach, Zeitschr. Pilzk. 5:31. 1925.

Boletus sanguineus var. *rhodoxanthus* Krombh., Naturg. Abbild. Schw. 5, pl. 37, *fig. 12-15.* 1836.

?*Boletus purpureus* Mich. *ex* Pers., Mycol. Europ. 2:143. 1825, *non* Secr. 1833, *nec* Fr. 1835.

Most authors have called this European species *B. purpureus* Fr., and so has the author (Ann. Mycol. 40:40. 1942). But for reasons not given by Kallenbach, this name cannot be maintained, and since Kallenbach's name is the only other one available, it must be applied to this species. *B. purpureus* is originally not Fries' species, but it represents *B. purpureus* Micheli *ex* Persoon. If an author in 1825, as does Persoon, says a species is little known. it has probably little chance of ever being recognized by a modern author unless validly emended by some author after 1825. However, the second time in post-Friesian times, Secretan uses *B. purpureus* in 1833 in an entirely different sense. What he describes is *B. Queletii.* Thus Secretan's *B. purpureus* becomes a homonym of Persoon's, and a synonym of *B. Queletii.* Fries, whose description of 1835 is in my opinion unrecognizable, describes *B. purpureus* again in 1838 and this description is, as pointed out by Kallenbach, a *mixtum compositum* of *B. Queletii, B. rhodoxanthus,* and *B. luridus.* However, this species of Fries's is of no nomenclatorial importance since Fries neglected to cite Micheli or Persoon, consequently considered his species as new. It is then a homonym and has to be discarded. There is only one way of reviving the familiar name *B. purpureus* so well introduced in French mycology. This could be done by studying the type locality which is indicated by Persoon as "In Boboli sylvulis circa piscinam Insulae." If it can be shown that the one purple bolete still growing there is none other than *B. rhodoxanthus,* the latter name would become a synonym of the thus validated *B. purpureus* Mich. *ex* Pers.

B. rhodoxanthus sensu Snell, is according to Snell *B. calopus.* The *B. purpureus* of Curtis is nothing but *B. Frostii.* Consequently, *B. rhodoxanthus* has not yet been observed in this hemisphere.

BOLETUS SATANAS Lenz, Schwämme, p. 67. 1831.

Boletus sanguineus Secr., Mycogr. Suisse 3:23. 1833; Krombh. 1836; *non* Sow. *ex* Kallenbach.
Boletus tuberosus Bull. *ex aut. gall. nonn.*
Boletus foetidus Trog, Flora 19(1):228. 1836.
?*Boletus marmoreus* Roques, Hist. Champ., p. 65, pl. 6. 1832.[12]

This species has been misunderstood by many, also by some American authors. It has thus far been observed with certainty only in Europe where it prefers lime soil. It is completely absent in sandy regions with a low percentage of Ca and is also absent in Northern Europe. What has been called *B. satanas* by the early American authors (Curtis and Schweinitz) was, probably always, *B. miniatoolivaceus* var. *subluridus* (Murr.) Sing. What Coker & Beers call *B. satanas* var. *americanus* is most probably not a variety of *B. satanas* but some other species of the section *Luridi.* Of all American collections, the Western *B. Eastwoodiae* seems to come closest to the true *B. sataras* (see the following notes).

BOLETUS EASTWOODIAE (Murr.) Sacc.& Trott., Syll. 21:237. 1912.
Suillellus Eastwoodiae Murr., North Am. Flora 9:152. 1910.

The spores of this species are, according to my own measurements, pale melleous, melleous, thin-walled, fusoid, smooth, (11.5)-13.3-15.7 x (3)-4-6μ,

12 Possibly not belonging here but to *B. rhodoxanthus* (Krombh.) Kall.

that is relatively narrower than the spores of *B. satanas* Lenz. The color of the pileus, the lesser extent of the reticulation of the stipe and the lack of an odor (?) would be additional differences. The more permanently bulbous stipe with a much less extensive network and probably different colors distinguish this from *B. rhodoxanthus* (Krombh.) Kallenbach which is equally close. Briefly characterizing this species, we may sum it up in the following way: It has the color and the spores of *B. rhodoxanthus* and the shape of the stipe and general appearance of *B. satanas* but is different from both.

Boletus luridus Schaeff. *ex* Fr. var. **caucasicus** nom. nov.

"*Boletus erythropus* Fr.—*luridus* (Schff.) Fr." Sing., Beih. Bot. Centralbl. **48**(II): 519. 1931.

This is intermediate between *B. erythropus* and *B. luridus* but seems to be closer to *B. luridus*. The varietal name *B. luridus* var. *caucasicus* is here proposed.

BOLETUS ERYTHROPUS (Fr. *ex* Fr.) Pers., Mycol. Europ. **2**:133. 1825, *p.p.*, *em.* Fr., *non* Pers. (1801) *ex* Kallenbach.

Boletus luridus var. *erythropus* Fr., Syst. Mycol. **1**:391. 1821.
Boletus miniatoporus Secr., Mycogr. Suisse **3**:28. 1833.
Boletus luridiformis Rostkov. in Sturm, Deutschl. Fl. **3**:105. 1844.
Dictyopus erythropus Quél., Enchir., p. 160, 1886.
Tubiporus erythropus Ricken, Vademecum, p. 205. 1918.

This species is frequent during summer and fall in fir woods of the Alps, for example near Neuhaus, Bavaria, where I have collected it frequently. It is also frequent in the montane woods of the Caucasus Mts. This form under firs has been well described by Konrad & Maublanc, Icon. Sel. 5, pl. 407. 1924-1938. Kallenbach seems to have it mostly from under *Fagus silvatica* and says it grows on soils poor or devoid of lime which does not agree with our observation at the Alpine localities. It may be that there are two forms loosely adapted to frondose or coniferous woods.

Persoon in 1825 considered *B. erythropus* as a species (the asterisk does not make it a subspecies as the Greek letters do) with a tolerable description and the citation of Fries, Observ. **1**:23 on the first place. This makes it impossible to choose the later synonym *B. miniatoporus* Secr. as the valid name of *B. erythropus* (Fr.) Pers.

Some chemical characters of this species are indicated by Kallenbach, *l.c.* p. 80. They are probably very similar to if not identical with those of *B. subvelutipes*.

BOLETUS MORRISII Peck, Bull. Torr. Bot. Cl. **36**:154. 1909.

Suillellus Morrisii Murr., North Am. Flora **9**:153. 1910.

I have seen one collection from deciduous woods in Corweeta Experiment Forest, N. C. (*10910*, NC)). This is different from all the other species I know, especially if it is true that this species constantly reddens only when injured. The hymenophore contains much soluble and slowly disappearing

rich yellow pigment like *Pulveroboletus auriporus* (Peck) Sing. The spores are 11.5-16.3-(18.5) x (4)-4.8-(6.8) μ; cystidia about 45 x 10μ, fusoid, often with a short ampullaceous neck or mucronate, hyaline; there are also balloon-shaped bodies on the pore mouths (pseudoparaphyses). The mycelium is distinctly yellow. The cuticle is made up by a trichodermium palisade of erect dermatocystidia which are versiform, rather long and slender in an average, fusoid, clavate, or filamentous, hyaline; all hyphae without clamp connections.

The rather strongly flocculose-pustulate stipe is reminiscent of *Leccinum*. However, the structure of the cuticle of the pileus does not support this suspicion, and it has to be assumed that *B. Morrisii* is an outstanding species of the section *Luridi*.

Species Imperfectly Known

BOLETUS FIRMUS Frost, Bull. Buff. Soc. Nat. Sc. 2:103. 1874.

Authentic material (FH) has few spores on the hymenium, and the ones present were winged like *Boletellus*-spores, and about 17 x 10μ. They may have come from *Boletellus Russellii* Frost. Otherwise the specimens examined did not reveal anything about the affinities of this species except for the strong network at the apex of the stipe which could almost belong to *B. Frostii* ssp. *typicus*. However, the network tapers out just below the upper third or fourth of the length of the stipe. The pileus must have been rather light colored, gray —as Krieger says who has observed this species in Canada. Unfortunately, he does not give more details about this unusual species which, as far as our personal knowledge goes, cannot be considered as sufficiently studied. The type came from Vermont.

BOLETUS MAGNISPORUS Frost, Bull. Buff. Soc. Nat. Sc. 2:103. 1874.

Authentic material (FH) shows rather small spores, smaller than in *B. junquilleus* (Quél.) Boud. which the description otherwise recalls. The spores are not as short as those of *B. Queletii* Schulz. but they were few and possibly not quite mature in our material. These observations are not sufficient for any conclusions.

BOLETUS SULLIVANTII Berk. & Curt. *apud* Mont. Syll. Crypt., p. 152. 1856.

I have not seen the type which comes from Ohio. This species may belong in the section *Luridi*.

BOLETUS DICHROUS Ellis, Bull. Torr. Bot. Cl. 6:109. 1876.

Boletus squamulosus Ellis, Bull. Torr. Bot. Cl. 6:77. 1876, *non* Rostkov. *in* Sturm (1844).

Type material is found in several herbaria. We have studied material preserved at NY and FH and find the spores 14.5-17.5 x 5.2-6.3μ, melleous, fusoid, with suprahilar depression, smooth; cystidia small, fusoid; hyphae of the cuticle of the pileus filamentous with some inflated terminal members, not strikingly mucilaginous, without clamp connections.

The spores are too large for *B. rubellus* ssp. *bicolor* (Peck) Sing, with which it is identical according to Murrill; they are also too large for *B. miniatoolivaceus* which is more similar than *B. rubellus* ssp. *bicolor*. It could be *B. rubricitrinus* Murr. as far as the spore measurements are concerned, but it appears somewhat unlikely that this Florida species should have been found so much farther north than its present northern limit. Aside from this, there is Ellis' remark about the viscosity of the cuticle of the pileus, a character irreconcilable to the characters of any of the above-mentioned species. Such a condition cannot be considered likely in *B. rubricitrinus* even after prolonged rains. It is possible that *B. dichrous* represents a now neglected or local species confined to a part of New Jersey. But it is also possible that Ellis' indication on the viscidity of the pileus is an error (the anatomy of the cuticle shows nothing to support his description), and that *B. dichrous* with the characters as given in the original diagnosis does not exist. The species has therefore been listed as "imperfectly known." There is, however, no doubt about its belonging in section *Luridi*, and it is obvious from the specimens that it has nothing at all to do with *Xerocomus badius*.

BOLETUS DISCOLOR (Quél.) Gilbert, Bolets, p. 172. 1931.

Dictyopus luridus var. *discolor* Quél., Flore Mycol. p. 422. 1888.

According to Quélet this is a form of *B. junquilleus* (or *vice versa*) while, according to Leclair it is a synonym of *B. Queletii*. Initially described as a variety of *B. luridus* from Central and Northern France, it is impossible to come to any conclusions without having seen authentic specimens. If no such specimens are in existence, it would be just as well to discard this species entirely.

Species Incertae Sedis and Species Excludendae

There are many species of *Boletus* which cannot be placed at present, as far as their section in *Boletus sensu stricto* is concerned, or even the genus to which they belong, either as autonomous species or as synonyms. They are, in fact so numerous that it will take type studies of the most extensive kind, including the reexamination of type localities to ascertain the correct position of at least some of them. In many cases there will be no way of making any conclusions even after all possibilities of rechecking are exhausted, and then these species will be entered in the list of *nomina dubia*.

There are also many species that have to be transferred from the genus *Boletus* in which they were described, to some of the recent segregates such as *Suillus em.*, *Gyroporus*, *Pulveroboletus*, etc.

We do not include these lists of species because of the space they would occupy. This space would not be in proportion to the size of the paper which is not intended to be a monograph of the boletes of the world, inasmuch as the reader will find a complete index at the end of part IV of the present paper from which he can check back and easily find the proper place of all species mentioned and described as *Boletus* or transferred to this genus by others. This takes care of the *species excludendae* of Florida and those extra-

limital species that have been treated here. As for the *species incertae sedis*, we refer to the general literature on boletes (Saccardo, Sartory & Maire), adding some species that have been published in the period between 1925 and now mainly by Cleland, Snell, and Beeli. If they are not represented in our index, they belong in the category of *species incertae sedis*. We can see no possible advantage in reprinting all these names only to state that we know nothing about them.

4(13). XANTHOCONIUM Sing., Mycologia **36**:361. 1944.

Characters of the genus: Pileus not scrobiculate; hymenophore of medium long tubes with fine pore-mouths, the latter concolorous or subconcolorous with the tubes, plainly adnate or adnexed, or more frequently depressed around the stipe; spores in print rusty yellow-brown to brownish yellow, without an olive hue even in the freshest preparation (except, perhaps, if the trama of the hymenophore has pressed on the support), about "antique brown," "raw sienna," "Sudan brown," "Argus brown," under the microscope bright golden, smooth, cylindric or fusoid-cylindric and rather narrow; basidia not voluminous; cystidia present; trama truly bilateral of the *Boletus*-type; stipe equal or ventricose, rather thick, glabrous or subglabrous, entirely smooth, solid; context white, unchanging; taste mild. On the ground in woods or in open places near conifers or frondose trees (not much specialized), in temperate and subtropical America. Type species: *Xanthoconium stramineum* (Murr.) Sing. (*Gyroporus stramineus* Murr.). The two known species both occur in Florida.

KEY TO THE SPECIES

A. Pileus white, later sometimes stramineous ..... 27. *X. stramineum*
A. Pileus distinctly colored from the beginning ..... 28. *X. affine*

27. XANTHOCONIUM STRAMINEUM (Murr.) Sing., Mycologia **36**:362. 1944.

Plate 1, Fig. 8 and Plate 2

Gyroporus stramineus Murr., Bull. Torr. Bot. Cl. **67**:62. 1940.
Leucogyroporus stramineus Snell, Mycologia **34**:408. 1942.
Gyroporus Woodiae Murr., Lloydia **6**:226. 1943.

Pileus white, later whitish or pale stramineous with white margin, eventually becoming stramineous or grayish or brownish on the areolae between the cracks when rimose in age, otherwise smooth and glabrous to very slightly pubescent on the margin when quite young, opaque, non-viscid, often more or less shining when dried, often with initially incurved and later projecting sterile margin, convex, eventually expanded, and eventually irregular when old, 45-85 mm. broad. — *Hymenophore* white, at maturity becoming dirty buffy cream or umbrinous-pallid and occasionally deeper brown at places from the spores, unchanging, adnate and with or without a slightly decurrent tooth (up to 1 mm.), or slightly depressed around the stipe; tubes 3-10 mm. long; pores minute, round and seemingly closed in young specimens, later angular and still small (10-15 to 5 mm.), often somewhat radially elongate next to the stipe, concolorous with the tubes or later either

paler or browner than the tubes, or remaining concolorous and very slightly staining brownish when touched; spore print "antique brown" or "raw umber," in thin layer often between "honey yellow" and "primuline yellow," or more "buckthorn brown," "Dresden brown" when caught in contact with the pores. — *Stipe* pure white, later whitish, unchanging when touched, glabrous, smooth, except for an extremely faint reticulation on the very apex of the stipe (a mere prolongation of the pores) in some of the very young specimens, practically constantly non-reticulate, non-viscid, equal or tapering downwards, or somewhat ventricose, sometimes with an unusual appendage at the base, solid, 30-60 x 10-35 mm.; mycelium white. — *Context* white, unchanging, thick, firm, eventually softer; odor none, or slight, fruity ("of anise" Murrill); taste mild.

Spores (9)-10.5-14.5 x 2.5-3.5μ, most freqently around 11μ long and 2.8-3.2μ broad, hyaline but always a majority with a brilliantly golden yellow sap, thin-walled and smooth, rod shaped, cylindric; *basidia* 24-35 x 8.5-11μ, 4-spored, both basidia and sterigmata in all regards normal for the Boletineae; *cystidia* 28-35 x 4.5-6.8μ, hyaline, fusoid or subulate, sometimes ampullaceous, very scattered and rare, soon disappearing, inconspicuous; *trama* truly bilateral of the *Boletus*-type, the mediostratum axillar, denser than the lateral stratum, with a few wavy-flexuous laticiferous vessels in some walls, the lateral stratum much more nearly hyaline, not very strongly divergent but loosely arranged; *cuticle* of the pileus apparently without any differentiated layer; hyphae without clamp connections.

Chemical reactions.—KOH on surface of pileus and context, negative; on pores, brown. — NH_3, NH_4OH, aniline and formol negative or almost negative in all parts. — HNO_3 on surface of pileus, yellow, otherwise negative. — $FeSO_4$ bluish slate gray. — Phenol on context, lilacinous-purple to chocolate brown.

Habitat.—In moderately dense mesophytic and low hammocks under oaks and in rather open places along flatwoods (*Pinus palustris*) or scrub (*Pinus palustris* and *Quercus Chapmanii*), also on lawns and in gradens under oaks (*Quercus virginiana* and probably other species) and under *Pinus taeda*, also in woods of *Quercus laevis* Walt.

Distribution.—Florida (except for the tropical zone).

Material studied.—FLORIDA, HIGHLANDS CO., Highlands Hammock State Park, Botanic Garden area and flatwoods, *Singer F 153, F 153 a, F 153 b* (FH); LAKE CO., sand shore of Lake Harris near Tavares, det. Murrill (as *Boletus* spec.) *F 15499* (FLAS); PUTNAM CO., near Lake Winn Ott (only label, *fide Murrill*); CLAY CO., Goldhead Park (only label, *fide* Murrill); Green Cove Springs (label only, *fide* Murrill); COLUMBIA CO., Camp O'Leno (label only, *fide* Murrill); ALACHUA CO., Melrose (label only, *fide* Murrill); Devil's Millhopper, *Miss Harriet Wood & Murrill*, TYPE of *G. Woodiae* (FLAS); Gainesville, *Murrill*, August 26, 1942; *Singer, F 2496 b* (FH); *Erdman West & Murrill* (det. Murrill as *B. roseialbus*, CO-TYPE of the latter[13]), *F 9287* (FLAS); TYPE of *G. stramineus* (FLAS); Dayville, *Singer, F 2496, F 2496 a*, (FH); Flatwood between Gainesville and Newnan's Lake, *Singer, F 2808* (FH); Cary Memorial Forest, *Murrill, F 21797* (FLAS).

This is one of the most remarkable species of Florida, striking because of the uniformly white color which often resembles fallen flowers of *Magnolia*.

13 The type of *G. roseialbus* is identical with *Gyroporus subalbellus* Murr.

The lack of pigment may be mimicry as well as protection against the direct sun to which many specimens are exposed. Deer eat this bolete eagerly. It is also palatable to man. *X. stramineus* can be readily recognized not only macroscopically but microscopically by its characteristic rod-shaped, golden yellow spores. The mild taste, smooth stipe and brownish yellow to yellowish rusty brown spore print distinguish it from *Tylopilus Rhoadsiae* which may be found in similar places.

28. **Xanthoconium affine** (Peck) Sing. comb. nov.

Boletus affinis Peck, Rep. N. Y. State Mus. **25**:81. 1873.
Suillus affinis Kuntze, Rev. Gen. Pl. **3**(2):535. 1898.
Ceriomyces affinis Murr. Mycologia **1**:149. 1909.
?*Boletus leprosus* Peck, Bull. N. Y. State Mus. **2**(8):135. 1889 (?=var. *maculosus*).

Var. TYPICUS

Pileus when young deep brown (from "Dresden brown" to "mummy brown"), then from "raw umber" to "Saccardo's umber," then "buckthorn brown" to "tawny olive" or "yellow ocher" to "raw sienna," or variegated with the following colors (of which one or several may be absent) "buckthorn brown," "honey yellow," "Dresden brown," "raw sienna," "bay," eventually often becoming "Isabella color," subtomentose-subglabrous to glabrous, non-viscid, becoming somewhat rimulose or rimose in age, otherwise smooth or somewhat roughened, pulvinate, then convex with applanate or somewhat depressed center, eventually often irregular, 40-110 mm. broad, rarely broader. — *Hymenophore* almost whitish when young, then "Isabella color" with or without some "cream buff," especially near the pores, becoming "honey yellow" when mature, unchanging, adnate or more frequently depressed around the stipe; tubes 7-15 mm. long; pores concolorous, unchanging or somewhat deeper yellowish or brownish when touched, round or subangular, small (2-4 to a mm.) to eventually medium-sized in very large specimens (but still relatively small); spore print between "raw sienna" and "antique brown," or between "Sudan brown" and "Argus brown." — *Stipe* white, later pallid or pale sordid and often partially "wood brown" or nearer the color of the hymenophore, remaining white or whitish at the base in most individuals, glabrous, smooth, or somewhat rough, never reticulate, versiform, either tapering upwards and downwards (ventricose), or tapering from the apex downwards, or thickened as well upwards as downwards (thinnest in the middle), or subequal to equal, solid, 40-52 x 10-25 mm.; mycelium inconspicuous, white. — *Context* white, unchanging; odor slight or distinct of *Leucocoprinus procerus;* taste mild.

Spores 11-13.7-(16) x 3-4μ, slightly more fusoid, *i.e.* not quite as strictly rod-shaped as in *X. stramineum,* and slightly less intensely golden but less frequently completely hyaline than in that species, smooth, thin-walled; *basidia* 24-26 x 8-8.7μ, 4-spored, often with golden-ferruginous contents in dried material; *cystidia* 30-62 x 8.7-11μ, ventricose with ampullaceous apex, often with golden contents or with a ferruginous incrustation, rather numerous on the pores; *trama* truly bilateral, of the *Boletus*-type; all *hyphae* without clamp connections.

Chemical reactions not studied.

Habitat.—Most frequently in open woods and in high and mesophytic hammocks, more rarely in low hammocks, near *Quercus virginiana* and other species of oak as well as near pines (*Pinus palustris* and *P. australis*), in the latter case some *Quercus minima, Q. nigra,* or at least *Cerothamnus cerifera* may be present but hardly in constant mycorrhizal connection with any of these species on sandy soil or on humus, more rarely on very decayed wood, solitary or in small to large groups. Fruiting from May until September.

Distribution.—From New England to South Florida and west to Indiana and Tennessee, not found in the tropical zone.

Material studied.—FLORIDA, HIGHLANDS CO., Highlands Hammock State Park, *Singer, F 361* (FH); ALACHUA CO., Wend Prairie near Gainesville, *Murrill F. 16504* (FLAS); Newnan's Lake, *Murrill, F 17690* (FLAS); *Singer, F 2178 a* (FH); Gainesville, *Singer, F 2158* (FH); *F 2083* (FH); Sugarfoot Hammock, *Singer, F 2569* (FH); CLAY CO., Gold Head Park, *Murrill, F 19626* (FLAS); Doctor's Inlet, *Murrill, F 20123* (FLAS). VERMONT, Brattleboro, *C. C. Frost,* one specimen under the correct name, another under an unpublished name, (FH). NEW HAMPSHIRE, Chocorua, *Farlow,* good spore prints (FH). MASSACHUSETTS, Dedham, *Rusden & Darker, 5369* (det. Snell), (FH); Arnold Arboretum, Hemlock Hill, Jamaica Plain, *Darker* (det Linder) *6225* (FH); Canton, *Linder, 1156* (FH). NEW YORK, Albany-TYPES (NYS). VIRGINIA, Mountain Lake, *Linder* (det. Snell), (FH).

Var. **maculosus** (Peck) Sing. comb. nov.

Boletus affinis var. *maculosus* Peck, Rep. N. Y. State Mus. **32**:57. 1879.

This has not been found in Florida but since it occurs in the northern states together with the type and south to North Carolina [Mass., Wellfleet, *Linder* (det Singer), (FH).—New York TYPE (NYS) and others], it may yet be found in Florida, especially in North Florida where the type form is so common. It differs only in whitish to cream colored stains all over the pileus. I have never seen spore prints with olivaceous hue.

5(14). TYLOPILUS Karst., Rev. Mycol. **3**:16. 1881.

Rhodoporus (Quél.) Bat., Bolets, p. 11. 1908 (type *B. felleus*).
Dictyopus (sect.) *Rhodoporus* Quél., Flore Mycol., p. 421. 1888 (type *D. felleus*).
Leucogyroporus Snell, Mycologia **34**:408. 1942. (type *G. pisciodorus*).
?*Rhodobolites* G. Beck, Zeitschr. Pilzk. **2**:146. 1923.

Characters of the genus: Pileus subglabrous to tomentose, sometimes scrobiculate, dry or viscid; cuticle of diverse structures, even sometimes cellular; hymenophore light colored or pallid, at least when young, usually depressed around the stipe, at least at maturity; pores small, not discolorous except by autoxydation when injured; spore print ranging all the way from a sordid pinkish flesh color to dull flesh ocher, or deep ferruginous-brown, wood brown, etc. ("light russet vinaceous," "russet vinaceous," "Rood's brown," "fawn color," "army brown," between "wood brown" and "fawn color," "pinkish cinnamon" with a shade of "fawn color," "vinaceous fawn," "cream buff," "Isabella color," "chamois," "amber brown"), often becoming paler after several months or years of preservation[14]), pale melleous to

14 This change is unusual because it is in contrast to what has been observed by the writer in the Russulaceae and Tricholomataceae where white or cream colored spore prints are likely to darken after prolonged preservation.

yellowish-subhyaline under the microscope, variable in shape, smooth, thin-walled; cystidia usually well developed, sometimes contrasting in color; trama truly bilateral of the *Boletus*-type; stipe either naked or covered with a palisade of hairs or dermatocystidia, often with a hymenium in the reticulate portions (when there are such); veil none; context whitish, never yellow, unchanging or changing but never bluing, mild (mild *and* unchanging only in *T. conicus* which has scrobiculate pileus), or very frequently bitter. Habitat in woods and hammocks, open pine lands, on lawns etc. on the soil. Type species: *T. felleus*. (Bull. *ex* Fr.) Karst. (*Boletus felleus* Bull.)

This well defined genus can easily be divided into three natural and convenient sections, only one of which is represented in Europe while all three are represented in Florida.

KEY TO THE SECTIONS

A. Context constantly unchanging on injury, unchanging with KOH, or turning yellowish with KOH and then the pileus scrobiculate-pitted.
  B. Pileus not scrobiculate-pitted; context rarely mild, not turning yellowish with KOH ..... Sect. *Fellei*
  B. Pileus scrobiculate-pitted; context mild, turning more or less yellowish with KOH ..... Sect. *Scrobiculati*
A. Context changing color when injured (sometimes rather slowly), becoming reddish or grayish violaceous, distinctly reacting with KOH in the spectes tested ..... Sect. *Oxydabiles*

Section **Fellei**, sect. nov.

Carne immutabili, plus minusve amara, raro miti vel submiti, KOH ope haud flavescente; pileo haud scrobiculato.

Characters of the section: see key and the above Latin diagnosis. The type species is *Tylopilus felleus* (Bull. *ex* Fr.) Karst.

KEY TO THE SPECIES

A. Stipe reticulate; pileus not violaceous when young.
  B. Pileus white to alutaceous white ..... 29. *T. Rhoadsiae*
  B. Pileus neither white nor alutaceous white.
    C. Stipe 50-68 x 7-13 mm., pallid to between "cinnamon" and "clay color" in the middle with paler apex and base, equal or tapering downwards; spores (8)-10-15-(16.3) x 3.3-4μ, the apex of the stipe finely concolorously reticulate; in frondose woods and in mesophytic and high hammocks ..30. *T. minor*
    C. Stipe as slender as above, or more frequently larger, especially thicker, ventricose, or tapering upwards or, with more or less thickened base, more strongly colored than no. 30, with a more extended belt between "cinnamon" and "clay color" or a similar color, usually up to the very apex, or if not so, the very apex rather yellowish colored, with a strong and distinctly elevated network which is often darker than the ground color (*e.g.* "sayal brown"); spores broader; in coniferous and mixed woods near conifers ..... 31. *T. felleus*
A. Stipe non-reticulate.
  D. Pileus initially violet; stipe at first bulbous, very thick .....27. *T. plumbeoviolaceus*
  D. Pileus not initially violet; stipe subequal, or thin and tapering downwards (see 30. *T. minor*, forms with non-reticulate stipes).

Description of the Species Occurring in Florida

29. TYLOPILUS RHOADSIAE (Murr.) Murr., Mycologia **36**:122. 1944.

Boletus felleus forma *albiceps* Kauffm. *apud* Snell, Mycologia **28**:466. 1936.
Gyroporus Rhoadsiae Murr., Bull. Torr. Bot. Cl. **67**:62. 1940.
Leucogyroporus Rhoadsiae Snell, Mycologia **34**:408. 1942.

Pileus white except for occasional "avellaneous" or "pinkish buff" or "pale ochraceous salmon," or "light pinkish cinnamon" portions, especially near the margin, sometimes somewhat guttate, center exceptionally reaching "warm buff" in some specimens, subtomentose, non-viscid, or very slightly sticky in prolonged rains, opaque or somewhat shining when dried, with narrowly projecting sterile margin which is pubescent when young, pulvinate, then convex or with flattened disc, 60-90 mm. broad. — *Hymenophore* whitish, then pale pinkish white, deeply depressed; tubes 9-16 mm. long; pores small, about 2 to a mm. in an average, concolorous and unchanging; spore print "light russet vinaceous" to "russet vinaceous." — *Stipe* white, strongly reticulate with a somewhat projecting concolorous (white) network with wide meshes, covering the upper half or the upper two thirds, glabrous, solid, equal or subequal, or slightly tapering upwards, or ventricose, 55-95 x 16-27 mm.; mycelium white. — *Context* white, unchanging; odor none or "bitter"; taste bitter.

Spores 11-13.7 x 3.7-4.5μ, fusoid, often more attenuate towards the apex (clavate), with a slight suprahilar depression, smooth, honey-yellow-hyaline; *basidia* 25-26 x 8-9μ, 4-spored, often with yellow contents; *cystidia* 36-43-(62) x (6)-6.8-8.3μ, fusoid, not ampullaceous and not rounded above but acutely attenuate or acuminate and subobtusate, yellowish guttulate or with a yellow central body, rather numerous in young specimens near the pores; *trama* truly bilateral of the *Boletus*-type; *cuticle* consisting exclusively of filamentous hyphae which are more nearly parallel and horizontally arranged towards the surface, the terminal members often in strands or in single hypha-ends which are erect or ascendant and have rounded tips, rarely cystidioid, capitate or ampullaceous, sometimes with yellow, guttulate contents, sometimes with an hyaline incrustation; all *hyphae* without clamp connections.

Chemical reactions.—KOH on context, negative or almost so. — Phenol and methylparamidophenol negative.

Habitat.—Near the margin of open pine lands and in flatwoods, also in mesophytic hammocks, connected with either pine or oak, not fully dependent on either of these trees, solitary or gregarious on sandy soil, from July till September.

Distribution.—Frequent in extratropical South Florida and becoming gradually less frequent towards the north, but reaching Michigan. The northern and western limits have not been established.

Material studied.—FLORIDA, Highlands Hammock. Numerous specimens in and around Highlands Hammock State Park, August and September 1942, *Singer, F 351* (FH); PUTNAM CO., at the margin of Lake Rosa, September 8, 1938, *L. & A. Rhoads*, TYPE of *G. Rhoadsiae* (FLAS); CLAY CO., Gold Head Park, *Watson*, July 9, 1939, AUTHENTIC, (FLAS); ALACHUA CO., Sugarfoot Hammock under *Pinus taeda* solitary, *Singer F 2594* (FH); Flatwoods between Gainesville and Newnan's Lake, *Singer, F 2844* (FH).

This is briefly defined as a white *T. felleus* although it certainly is not an albino form but an autonomous species. It occurs in groups of uniformly colored carpophores and no *T felleus* has ever been seen in their neighborhood.

30. TYLOPILUS MINOR Sing., Mycologia 37:799. 1945.

Pileus between "Verona brown" and "fawn color" when young, becoming about "sayal brown" or "cinnamon buff," or eventually "winter leaf" (M. & P.), sometimes with an avellaneous hue, or somewhat deeper colored than indicated above but in the same colors, decidedly non-viscid, opaque, subglabrous to slightly tomentose, pulvinate, becoming plane in age, 38-57 mm. broad. — *Hymenophore* whitish, then pale and sordid pink, slightly to decidedly depressed around the stipe, unchanging or almost so when wounded; tubes about 6 mm. long; pores concolorous, small, about 11-12 per 5 mm. or 0.2-0.3-(0.7) mm. in diameter; spore print as in the preceding species. — *Stipe* white, whitish, then often assuming a color between "clay color" and "cinnamon," especially in the middle but leaving large portions especially at the apex and the base pigmentless, entirely brownish in some specimens when very old, with a fine (finer than in *T. felleus*), wide-meshed, concolorous (*i.e.* mostly whitish) reticulation at the apex, leaving the lower, larger portion of the stipe smooth, more rarely entirely smooth, even at the apex, glabrous, solid, equal or subequal, but the base often acuminate, more rarely tapering downwards, appearing subradicate, 50-68 x 7-13 mm.; mycelium white. — *Context* white, unchanging; taste bitter, often becoming milder with age; odor none, or weak, agreeable.

Spores (8)-10-13.5 x 3.5-4 μ, or 10.2-15-(16.3) x 3.3-3.5-(4.8) μ, yellowish hyaline or hyaline, smooth, fusoid or clavate-fusoid, thin-walled; *basidia* 27 x 7 μ, 4-spored; *cystidia* 38-49 x 4.8-7 μ, fusoid, on the pores often strongly yellowish incrusted, besides with yellowish guttulate contents, the incrustation slowly dissolving in ammonia; the abundance of the colored cystidia on and near the pores is so great that the whole region is yellow under the microscope while the rest of the hymenium is hyaline or nearly so; all *hyphae* without clamp connections.

Chemical reactions.—KOH on surface of pileus, ochraceous brown; on context, negative, and not causing any remarkable change if applied after the reaction with $FeSO_4$ has taken place. — NH_4OH little reaction. — HNO_3 on surface of pileus, ochraceous brown. — $FeSO_4$ on context, immediately pale sordid caesious to glaucous.

Habitat.—In hammocks, mostly mesophytic hammocks with intermixed *Magnolia* or *Pinus palustris*, always in the neighborhood of *Quercus*, solitary or in small groups. Fruiting from May till August.

Distribution.—North Florida.

Material studied.—FLORIDA, ALACHUA CO., mesophytic hammock 2 miles south of Gainesville, *Singer, F 2213* (FH); Kelley's Hammock, *Singer, F 2717*, TYPE (FH); *F 2979*, CO-TYPE (FH).

This species is closely related to *T. felleus* but, in my opinion neither a geographic race nor a mere *forma nana* but constant in its distinguishing characters, and with a geographical area more southern than that of *T. felleus*.

31. **Tylopilus plumbeoviolaceus** (Snell) Snell, Mycologia **33**:33. 1941.

Boletus felleus forma *plumbeoviolaceus* Snell, Mycologia **28**:463. 1936.
Boletus plumbeoviolaceus Snell, Mycologia **33**:32. 1941.

Pileus "dull lavender," "dark heliotrope gray," "heliotrope slate," "dark vinaceous drab," some portions soon becoming "dusky brown" or "pale brownish drab," eventually mostly "drab," the discoloration starting mostly after exposure to the sun, dry and practically non-viscid in the center, viscid in the marginal half when exposed to rains for a prolonged period and remaining shining there after it has dried out while the disc is opaque, subglabrous, then glabrous, pulvinate, eventually frequently flattened, with somewhat projecting sterile margin and the latter sometimes separating from the pileus by a circular scission, 68-152 mm. broad. — *Hymenophore* white, then assuming a color between white and "sea shell pink," eventually "light russet vinaceous" with "sorghum brown" shades, depressed around the stipe; tubes 10-15 mm. long; pores concolorous, small, less than 1 mm. in diameter, usually 2-3 to 1 mm., subangular and not quite regular but not radiately elongate when old; spore print "light russet vinaceous." — *Stipe* "pale vinaceous drab" to "light vinaceous drab," mostly somewhat marbled with paler tints when young, becoming "light cinnamon drab," usually with a pallid, inconspicuous spurious network of continuing pores on the extreme apex of the stipe running down not more than 3 mm. at most, all the rest of the stipe decidedly smooth, glabrous, dry, solid, thick-ventricose, almost bulbous or bulbous when young, mostly becoming cylindric in older specimens, 40-90 x 32-56 mm. — *Context* white, unchanging, "light vinaceous drab" immediately under the cuticle, assuming the violet pigmentation also where wounded and exposed for a long time during the period of intensive growth, fleshy and thick, hard when young, especially in the stipe; taste very bitter; odor insignificant, not disagreeable.

Spores 9.5-14 x 3-3.8μ, most frequently 10.2-12 x 3.3-3.5μ, fusoid-cylindric, without suprahilar depression or with a very slight one, the broadest part in the middle or in the lower third, thin-walled and smooth, pale melleous or light golden melleous (not so golden and not so intensively colored as in *Xanthoconium*, — young spores entirely hyaline); *basidia* 21-24 x 7.5-8.5μ, 4-spored; *cystidia* 32-56 x 6-15μ, enormously numerous on the pores as well as in the tubes, with a striking golden yellow incrustation, and also pale golden yellow contents in many cases, the attenuate or thin, ampullaceous, often acuminate though at the very tip obtusate apices hyaline and free from incrustation, the main part fusoid; *trama* truly bilateral, of the *Boletus*-type,

the lateral stratum very loose, strongly and entirely divergent and quite hyaline; all *hyphae* without clamp connections.

Chemical reactions.—KOH on surface of pileus, bleaching to a pale isabelline; on pores pale isabelline; on context, negative or a very pale and sordid salmon color, at places almost bay. — NH_3 and NH_4OH negative everywhere. — H_2SO_4 on surface of pileus, bleaching to a pale isabelline; on pores brownish. — $FeSO_4$ on context, slowly and weakly reacting, becoming pale sordid gray; if KOH is added later, the reacting portion of the flesh becomes pale sordid salmon or pale sordid vinaceous, at places sordid bay (likewise slow reaction). — Methylparamidophenol everywhere negative.

Habitat.—On earth under oaks, either on bare sandy soil or among grasses, gregarious from May until fall.

Distribution.—From Massachusetts south to Florida and west to Tennessee and Mississippi.

Material studied.—FLORIDA, ALACHUA Co. Common in and around Gainesville, *Singer F 1897, F 1897 a, 1897 aa* (FH); *F 2151, F 2151 a* (FH), etc. RHODE ISLAND, East Providence, *Farlow* (det. Singer, conf. Snell), AUTHENTIC (FH, with excellent plate and notes); also paintings from Massachusetts material by Krieger. MISSISSIPPI, *Tice* (det. Curtis as "*B. subtomentosus ?*"), (FH).

Snell had this species from New York and Tennessee. The type is in the Walter H. Snell Herbarium (Providence, R. I.). This species is very different from *T. felleus* although it belongs to the same section. It has been silently accepted by American authors as a color form of *T. felleus,* without regard to the fact that the European form does not show such aberrant colors and has constantly reticulated stipe. It is incomprehensible that a strikingly beautiful, not too rare species like this has not been recognized long before it was described by Walter Snell. Specimens determined as *T. felleus* in America up to 1941 should be revised; indications in lists ought to be used with caution. The true *T. felleus* does occur in North America, but not in Florida.

Boletus violascens Martin from Switzerland is known to me only from the description in Saccardo. It seems to me that no one else has ever seen it in Europe. Assuming that *T. plumbeoviolaceus* exists in Europe though rarely, one may be led to believe that the diagnosis of *B. violascens* is just an awkward attempt to describe *T. plumbeoviolaceus* from insufficient material. In the case that there should be no type material worthy of examination, the only way to make sure whether this is the same as *T. plumbeoviolaceus* would be an intensive search at the type locality. It may be hoped that the otherwise very active members of the Swiss Mycological Clubs will cooperate.

The slow maturing of the spores indicated by Snell, *l.c.* finds its explanation in the fact that in young specimens the cystidia are so crowded and consequently the incrustations so dense that the formation of normal basidia is suppressed until sufficient space is provided in fully grown carpophores for the development of the even then inconspicuous basidia. The spores are indicated as 7-11 x 2.8-4μ, mostly 8-9 x 3μ, by Snell but I have checked

my findings on Florida material as well as on northern material, and I find the measurements given in my description reasonably constant.

Extralimital Species

TYLOPILUS FELLEUS (Bull. *ex* Fr.) Karst., Rev. Mycol. 3:16. 1881.

Boletus felleus Bull. *ex* Fr., Syst. Mycol. 1:394. 1821.

This is well represented in many European books, the best illustration and description is found in Kallenbach, Pilze Mitteleuropas 1:131-138, pl. 42, *figs. 1-22*, pl. 47, *figs. 77-78*. 1938. It also occurs in North America. The spores are 10.5-15.5-(18) x 4.2-4.5μ; the cystidia are fusoid-subventricose with ampullaceous apex, hyaline; the trama is truly bilateral of the *Boletus*-type; all hyphae are devoid of clamp connections. The color of the pileus is "cinnamon" with "snuff brown" center, or "cinnamon," "snuff brown," and "sayal brown" mixed (much the same as in *T. ferrugineus*). NH_4OH does not react with any part of the carpophore nor does H_2SO_4 on the context; on the tubes however, it causes a ferruginous then brown-yellow reaction. $FeSO_4$ makes the context of the pileus gray-reddish. The context of the stipe and the plane of attachment of the hymenophore become more gray, the interior of the context more reddish. Guajacol does not cause any discoloration. The spore print is "fawn color" to "army brown" when fresh. The habitat is under various conifers.

My own collections from Middlesex and adjacent counties of Massachusetts are identical with the European type in all regards. However, Snell also mentions a form which I have not seen. He calls it *Boletus felleus* f. *rubrobrunneus* Snell, Mycologia 28:463. 1936.

Section **Scrobiculati**, sect. nov.

Pileo scrobiculato; carne immutabili, miti; reactione KOH flavida; stipite albo, levi.

Characters of the section: see the key of the sections, p. 90, and the above Latin diagnosis. The type and only species is *T. conicus* (Rav. *apud* B. & C.) Beardslee.

32. TYLOPILUS CONICUS (Rav. *apud* B. & C.) Beardslee, Mycologia 26:253. 1934.

Boletus conicus Rav. *apud* Berk. & Curt., Ann. Mag. Nat. Hist. II. 12:430. 1853.
Suillus conicus Kuntze, Rev. Gen. Pl. 3(2):535. 1898.
Ceriomyces conicus Murr., Mycologia 9:146. 1909.

Pileus with uneven surface of elevated ridges around small depressions (scrobiculate) that give the pileus a characteristic pitted appearance, the most elevated ridges "Sudan brown," "raw sienna," "yellow ocher," the lower ones "mustard yellow," the depressions (since they are naked context) white, but the pileus giving the general impression of about "primuline yellow,"

more pitted near the margin, dry, pulvinate to convex, 25-95 mm. broad. — *Hymenophore* "pale grayish vinaceous" to "pale vinaceous fawn" when mature, paler when immature, depressed around the stipe; tubes about 14 mm. long; pores small, equal, concolorous and unchanging, 8-10 per 5 mm. radially, 10-11 per 5 mm. tranversely; spore print "Rood's brown." — *Stipe* white, at least at the apex and at the base, the middle portion usually with a flush of "light pinkish cinnamon" and "chamois," smooth to minutely rugulose at places, entirely glabrous, ventricose to subequal, 40-70 x 6-18 mm.; mycelium white. — *Context* pure white with a hyaline line above the tubes; odor agreeable, fruity; taste mild.

Spores 14.2-17.7-(21) x 4-6μ, fusoid, the upper half attenuate, with thin, rarely in some exceptional spores with slightly thickened walls (0.8μ), hyaline and becoming melleous or brownish melleous only at maturity, with distinct or indistinct suprahilar depression, with small oil-drops inside, smooth; *basidia* (17.5)-27.5-30 x 10-11.6μ, 4-spored; *cystidia* 41-68 x 4.8-8.5μ subfusoid, often with 1-2-(3) septa, hyaline but frequently with a melleous incrustation; *trama* truly bilateral of the *Boletus*-type; *cuticle* of strands of very slender, and others of medium thick (4.5-8μ in diameter) hyphae; these *hyphae* are alternately hyaline and deep honey color with dissolved pigment, somewhat interwoven and repent but a few ascendant to erect, all without clamp connections.

Chemical reactions.—KOH on surface of pileus, deeper colored, eventually brown; on context of pileus, yellow, eventually brown. — NH_4OH on surface of pileus, deeper and richer colored, eventually brown; on context of pileus, negative except for the margin which usually assumes the color of the tubes. H_2SO_4 on pores, negative. — $FeSO_4$ on context of pileus, negative but if treated with KOH subsequently, the context becomes brownish; on tubes with $FeSO_4$, grayer, eventually steel gray. — Formol on surface of pileus and on context, negative. — Methylparamidophenol on context and tubes, negative.

Habitat.—In flatwoods under *Pinus palustris,* often on soil that is at times partly inundated. Fruiting in July.

Distribution.—From South Carolina to Florida, but not in the tropical zone.

Material studied.—FLORIDA, ALACHUA CO., in a flatwood east of Gainesville, *Singer F 2780* (FH). SOUTH CAROLINA, Santee Canal, *Ravenel, 1024,* TYPE (FH).

This is, as has been pointed out by Beardslee, one of the most striking boletes of the south, and very few mycologists have ever seen it. It has been collected by Ravenel, Beardslee and this writer, that is three times in nearly a century. It grows in small number in places where ordinarily few Agaricales would be expected. Ravenel's type consists of small specimens. This plant, however, reaches considerable size if well developed. This obviously depends on the weather conditions, and well formed specimens may be found when continuous rainfall favors its growth until it has reached its maximum size. Unfortunately, Beardslee did not indicate the locality and county in which his Florida collections were made; we may assume it was in central

peninsular Florida. The specific epithet "conicus" is regrettable since it is misleading as far as normally developed specimens are concerned.

Section **Oxydabiles**, section. nov.

Pileo haud scrobiculato; carne violascente vel rubente vel grisente, amara vel miti; KOH ope discolorante.

Characters of the section: see key, p. 90, and the above Latin diagnosis. Type species: *Tylopilus tabacinus* (Peck) Sing. (*Boletus tabacinus* Peck).

Gilbert considered the species of this section as belonging in *Porphyrellus*. All he knew about them were not too good descriptions. None of the species of this group occurs in Europe.

KEY TO THE SPECIES

A. Spores ellipsoid to ovoid, about twice as long as broad, or shorter (Q=2, or less).
  B. Cuticle of filamentous hyphae ..... *T. Balloui*
  B. Cuticle of chains of short hyphae and spherocysts ..... *T. veluticeps*
A. Spores fusoid or cylindric or ellipsoid-oblong, or clavate-elongate with Q larger than 2.
  C. Pileus blackish umber, deep fuliginous, dark fuscous.
    D. Cuticle of the pileus with an epithelium ..... *T. cellulosus*
    D. Cuticle of the pileus formed by a palisade of stiff hairs or dermatocystidiod terminal members of hyphae-chains.
      E. Cystidia with ampullaceous apex; spores cuneiform-clavate with a Q less than 3 (*i.e.* spores less than three times longer than broad) ....33. *T. alboater*
      E. Cystidia not all ampullaceous; spores cylindric and three times as long as broad in an average ..... *T. nigricans*
  C. Pileus purplish brown to chocolate brown, reddish brown, ochraceous brown, pale alutaceous. cinnamon, even whitish, sometimes with pinkish areas.
    F. Spore print "amber brown"; spores large, 13.5-23.5 x 3.5-5.5μ ..... *T. eximius*
    F. Spore print not "amber brown" (not as rusty brown as this, rather dull yellowish, wood brown, or pinkish); individual spores smaller than indicated above, rarely some spores in a print larger than 14.5μ.
      G. Taste mild; odor none; context white before autoxydation takes place; spores broader than 2.3-3.5μ.
        H. Winter fruiting species in Florida ..... (see *B. alachuanus*)
        H. Either not winter-fruiting, or not occurring in Florida..... *T. ferrugineus, T. indecisus, B. decorus, B. subpunctipes, B. subdecorus, B. pseudodecorus*
      G. Taste not mild *or* odor strong, *or else* the context partly brown before autoxydation starts, *or* spores only 2.3-3.5μ broad.
        I. Pileus "snuff brown," "Argus brown," "buckthorn brown"; odor of guava, or fishy, or both these odors present at the same time; stipe reticulate at the apex; spores 11.8-14.5-(17) x 3.5-5μ; spore print between "wood brown" and "fawn color," or "vinaceous fawn" ..... 34. *T. tabacinus*
        I. Pileus whitish, or "chamois" to "antimony yellow," or more umber, or with a salmon colored ("ochraceous salmon") zone, often stained with "cinnamon brown" or "Prout's brown" but not prevalently in these colors; odor slight, somewhat acid, or of chloride of lime, or of anise, not of guava and not of fish; stipe never reticulate in any part; spores 10.5-13.5 x 2.3-3.5μ; spore print "cream buff," "chamois," "Isabella color," rarely "vinaceous fawn" in a very distinctly bitter variety ..... 35. *T. peralbidus*

Description of the Species Occurring in Florida

33. TYLOPILUS ALBOATER (Schwein.) Murr., Mycologia **1**:16. 1909.

Boletus alboater Schweinitz, Schr. Naturf. Ges. Leipzig **1**:95. 1822.
Boletus nigrellus Peck, Ann. Rep. N. Y. State Mus. **29**:44. 1878.
Suillus alboater Kuntze, Rev. Gen. Pl. **3**(2):535. 1898.
Suillus nigrellus Kuntze, Rev. Gen. Pl. **3**(2):535. 1898.
Porphyrellus alboater Gilbert, Bolets, p. 99. 1931.
Porphyrellus nigrellus Gilbert, Bolets, p. 99. 1931.

Pileus very dark brown to nearly black with a grayish bloom, dark smoky drab with a fleshy tint to brownish gray, distinctly velutinous, dry, with projecting sterile margin which is incurved at first, convex to nearly flat or irregular, 60-110 (-280) mm. broad. — *Hymenophore* white or pale gray, later flesh colored, changing slowly to black, or reaching blackish through pink or purplish brown when wounded, adnate to depressed with decurrent lines; tubes 5-10-(12) mm. long; pores variable in shape and size, 1-3 per mm., not stuffed at first but crowded and folded together, later rounded-angular, concolorous and changing as tubes when touched; spore print deep rosy salmon or dull flesh colored. — *Stipe* concolorous with the pileus but paler at the apex at least when young, usually reticulated above, the longitudinal lines much stronger than the cross veins, more rarely practically non-reticulated even at the apex, pruinose to velvety, black when rubbed, usually heavy and irregular, or subequal, largest below or rarely above, solid, 50-105 x about 15-25 mm. — *Context* white to creamy gray, changing to pinkish gray, pinkish or purplish brown when bruised, then becoming blackish, firm in the stipe, thick in the middle of the pileus; taste mild, sometimes nutty; odor none.

Spores 9-13 x 4-4.8μ, subclavate, broadest near the lower end, pale brownish melleous, thin-walled, or sometimes some moderately thick-walled, smooth; *basidia* (24)-38 x 7.3-8μ, 4-spored; *cystidia* 60-65 x 11-12μ, constantly ampullaceous as in *Leccinum scabrum*, brown, the neck 24-34 x 3.5-4.5-(6.5)μ; *hyphae of the trama* brown, at least in the mediostratum of dried mature specimens, in young specimens truly bilateral of the *Boletus*-type with the mediostratum colored and dense and the lateral stratum hyaline and loosely arranged, divergent; *cuticle* made up of a palisade of hairs which are dark fuscous, slightly attenuate upwards but bluntly rounded at the very tip, very brittle, often thick-walled (walls 0.6-0.9μ thick), very densely arranged, 4-7.5μ broad, sometimes reaching 12μ in breadth; palisade of the surface of the stipe with the same kind of hairs; all *hyphae* without clamp connections.

Chemical reactions not studied.

Habitat.—In mixed woods and in low places near deciduous trees, often during dry weather in large quantity (Snell), on the soil. Fruiting from July till September.

Distribution.—From New York and New England to North Florida and west to Mississippi. In Florida rare.

Material studied.—FLORIDA, ALACHUA Co., Gainesville, *Murrill*, July 27 (FLAS); COLUMBIA Co., Camp O'Leno, *Murrill, F 21801* (FLAS). NEW YORK, Sandlake, *Peck*, TYPE of *B. nigrellus* (NYS). NORTH CAROLINA, Great Smoky Mts., National Park, Swain Co., *Hesler*, August 1, 1937 (FH).

This species is remarkable for its color and it can therefore safely be assumed that Schweinitz's plant is what is now generally called *Tylopilus alboater*. We have, however, not seen authentic material. We have also not collected this species in fresh condition, and the above description is, as far as macroscopical characters are concerned, strongly inspired by published descriptions of authors who know it well in fresh condition, such as Peck, and especially Coker & Beers.

Paler specimens that may occasionally be confused with *T. ferrugineus* and allied forms, and also deeper colored forms of the latter that may be taken for *T. alboater*, can easily be distinguished in dried condition if it is remembered that the cystidia of *T. alboater* are brown while those of *T. ferrugineus* and allied forms are yellow.

34. TYLOPILUS TABACINUS (Peck) Sing., Mycologia **36**:362. 1944.

Boletus tabacinus Peck, Bull. Torr. Bot. Cl. **23**:418. 1898.
Ceriomyces tabacinus Murr., Mycologia **1**:151. 1909.
Gyroporus pisciodorus Murr., Mycologia **31**:111. 1939.
Boletus pisciodorus Murr., Mycologia **31**:112. 1939.
Leucogyroporus pisciodorus Snell, Mycologia **34**:408. 1942.

Var. TYPICUS

Pileus "Argus brown," at some places "buckthorn brown," velutinous, dry, smooth, margin often minutely wavy, pulvinate, becoming flatter, 45-175 mm. broad. — *Hymenophore* whitish to sordid white, later with Sanford's brown," patches and stains on the otherwise concolorous pores, or the pores brown almost from the beginning, adnate, becoming depressed around the stipe; tubes 10-14 mm. long; pores small, becoming medium wide in large, old specimens (1-2 to a mm.); spore print between "wood brown" and "fawn color," or "vinaceous fawn." — *Stipe* almost concolorous with the pileus, subvelutinous, smooth in the lower part, with a "hazel" network on paler ground in its upper portion (one tenth to one third), this reticulation with rather wide meshes, but often with strongly and permanently raised veins, solid, ventricose to subventricose, almost globose-bulbous when young, mostly elongate and subcylindric though very thick when old, mostly acuminate to the very base, 40-164 x 25-60 mm. — *Context* white becoming slate violet as in *T. peralbidus* when cut, the base of the stipe often from the beginning slate violet, or more often brown, always brown in old and in dried material; taste mild or very slightly bitterish; odor initially weak, fruity, later strong and compound, of guava paste, and at the same time of old, emptied fish cans, the latter odor sometimes wanting, both odors, especially the guava odor, rather persistent even in dried condition for a short while.

Spores (8.8)-11.8-14.5-(17) x (3.5)-4-5μ, most frequently 11.8-13.8 x 4.2-4.5μ, fusoid, fusoid-ellipsoid, fusoid-cylindric, often a high percentage fusoid-clavate with strongly attenuate upper half, hyaline to pale melleous, smooth, thin-walled, exceptionally a few spores abruptly ventricose in the middle and then up to 5.5μ broad; *basidia* 28-30 x 7.5-8.5μ, 4-spored; *cystidia* 18-45 x 4.5-8.5μ, hyaline or yellowish-melleous, very versiform, most frequent-

ly fusoid-clavate or fusoid-ampullaceous, with rather thin walls, very crowded on the pores, scattered in the tubes, a few more distinctly incrusted by a thin castaneous crust; *trama* truly bilateral, of the *Boletus*-type, the mediostratum of axillar, denser hyphae, many of which are strongly colored, lateral stratum of strongly and entirely diverging, for the most part hyaline hyphae; *cuticle* with a distinct epicutis of erect and at places densely packed into a palisade, versiform hairs; these hairs either hyaline or pale melleous, some with, some without a fulvous-castaneous resinous incrustation that often forms a hood on the apex of the hair, with rather thin to very thin smooth walls, 27-39 x 5.5-10.5μ; covering of the stipe of similar elements; all *elements of the carpophore* are either naked or covered with incrustation, in every carpophore both types present, all septa without clamp connections.

Chemical reactions.—KOH on surface of pileus causing the color to become much deeper; on context, yellow. — NH_4OH on surface of pileus as with KOH; on context, dirty buff. — HNO_3 on context, somewhat yellow. — $FeSO_4$ on context, deep bluish slate gray; if stained with KOH afterwards, the stain becomes deep red. — Formol intensifying the autoxydation of the context.

Habitat.—Under *Quercus virginiana* and *Q. laurifolia*, rarely under other oaks, frequently in high hammocks and on shady lawns. Fruiting from June until August.

Distribution.—From South Carolina to North Florida and west to Alabama.

Material studied.—FLORIDA, ALACHUA CO., common in and around Gainesville, especially in July, many AUTHENTIC (for *B. Pisciodorus*) collections, *Murrill*, also *Singer* (conf. Murrill as, *B. pisciodorus*); TYPE of *G. pisciodorus*, etc. (FH, FLAS); MARION CO., Caroll's Cottage near East Lake, *Tisdale* (det. Murrill), *F 19951*, (FLAS); PUTNAM CO., Lake Swan, *A. S. Rhoads* (det. Murrill), *F. 19938* (FLAS). SOUTH CAROLINA, Clemson College, July 1900, *Rolfs* (det. Peck), very good, AUTHENTIC material (NYS). ALABAMA, *Underwood*, TYPE; *Earle* (?), (NY).

This interesting species is related to but different from *T. ferrugineus* and its allies. It is this species which Snell studied and based upon the genus *Leucogyroporus*. Murrill says this species is edible and very tasty. One will, however, do well to avoid the following variety if use is made of the edible qualities of this species.

Var. AMARUS Sing., Mycologia 37:799. 1945.

Pileus "snuff brown" in the center, pale towards the margin, reaching "pinkish buff" near the margin but the very margin occasionally "amber brown" to "Argus brown" (as in the type variety), 80-100 mm. broad. — *Hymenophore* 5-6 mm. in diameter; pores small; spore print between "wood brown" and "fawn color." — *Stipe* "snuff brown" at the base and with very minute "snuff brown" floccons on "pinkish buff" or "pale pinkish buff" ground in the lower half of the stipe, apical third same color but with fine though distinct "snuff brown" network, solid, subequal with slightly widened apex, or tapering downwards, 40-70 x 22-35 mm. — *Context* pure white but "snuff brown" in the stipe and sometimes also under the cuticle, turning

"avellaneous" in the pileus when injured; odor same as in the type variety; taste moderately but very distinctly bitter; otherwise as var. *typicus*.

Spores and other microscopical characters as in var. *typicus*.

Chemical reactions as in var. *typicus*.

Habitat as in var. *typicus*.

Distribution.—Known only from the type locality.

This variety when first seen was thought to be a separate species differing not only in the taste but also in color. Later, however, the narrow, tobacco-colored marginal zone was discovered, and among our specimens of var. *typicus* we have one that is transitory insofar as it has the same color of the pileus as the bitter variety. After these facts had been taken into consideration, it seemed better to consider var. *amarus* the bitter form of *T. tabacinus*. The mild, lighter colored form which we may consider as a transient form would be closest to *T. ferrugineus;* yet in this form the yellow cystidia were least distinct and the spores larger than usual in *T. ferrugineus;* besides, there is still the brownish color of the context in the base of the stipe or the entire stipe in fresh specimens, and their odor of guava and fish in fresh condition, all characters that *T. ferrugineus* and allied forms are not supposed to show.

The yellow color of the cystidia in some specimens is nearly comparable to that of *T. ferrugineus* though not quite as striking, while in other specimens the cystidia are mostly hyaline, and some are merely incrusted with a melleous to fulvous or castaneous resinous cover, making them all shades of honey color.

Var. DUBIUS Sing., Mycologia 37:799. 1945.

Pileus "cinnamon" to "ochraceous tawny" on the margin and "pinkish buff" or a similar color in the center. — *Pores* "cinnamon," tubes paler. — *Stipe* at the apex with an indistinct, rather coarse incomplete network which is likely to be overlooked. — *Context* with large brown areas in the stipe; odor of guava; taste mild or submild.

Spores and other microscopical characters as in var. *typicus*.

Chemical reactions as in var. *typicus*.

Habitat.—Under live oaks (*Quercus virginiana*) in W. Gainesville, July 1943, *Singer, F 2904* (FH).

Distribution.—Known only from the type locality.

This is evidently closer to *T. ferrugineus* than either var. *typicus* and var. *amarus*. However, the characters of the context, and the less yellow cystidia, cause me to retain it with *T. tacabinus* (Peck) Sing., as another variety.

35. TYLOPILUS PERALBIDUS (Snell & Beardslee) Murr., Mycologia 30:521. 1938.

Boletus peralbidus Snell & Beardslee *apud* Snell, Mycologia 28:471. 1936.

Var. TYPICUS

Pileus "chamois" to "antimony yellow," margin frequently white when young and fresh, occasionally white all over when young, sometimes with

salmoneous shades ("ochraceous salmon"), often stained with "cinnamon brown," or "Prout's brown," or becoming so on pressure when fresh, subglabrous to subtomentose, or tomentose, dry, pulvinate or plainly convex, then with flattened and finally depressed center or remaining convex on the disc, 45-130 mm. broad. — *Hymenophore* pallid to pinkish-avellaneous-white, slowly changing to "buff pink" or "vinaceous fawn," or "pale pinkish buff" when cut (not from the spores which are never this color), adnate, soon depressed around the stipe; tubes (3)-6-10 mm. long; pores concolorous with the tubes but staining "sayal brown" where touched when young and fresh, very small when young but becoming medium wide and some of them even rather wide, at least old specimens (0.4-1.2 mm. in diameter); spore print from "cream buff[15]) to "chamois" or "Isabella color" depending on the thickness of the spore layer, neither pink nor olivaceous when fresh. — *Stipe* white or partly (below) or entirely concolorous with the pileus, frequently with a shade of "wood brown," glabrous and smooth, or, when seen under a lens, with "chamois" punctiform floccons, thick and equal, or tapering upwards, or downwards, or ventricose, solid, 45-110 x 13-40 mm. — *Context* white, usually marbled with hyaline. slowly changing to "buff pink" or "vinaceous fawn" or some color between these when injured; taste moderately but constantly bitter; odor either almost absent, or of chloride of lime.

Spores 7.5-9.5 x 2.3-3.5μ, melleous-hyaline, cylindric or cylindric-subclavate, smooth, the inner profile subconcave or without any depression, strikingly small and narrow when compared with the spores of other species of this genus; *basidia* 27-34 x 7.5-9.3μ, 4-spored; *cystidia* of two types, either yellow and of irregular occurrence, similar in shape and size to those of the genus *Suillus*, or, in the other type, occurring in the same hymenophores, hyaline, fusoid or clavate-fusoid with acuminate apex but with the very tip subobtusate, the upper attenuate portion shorter than in the average of the cystidia in related species, only in a few scattered cystidia the apex anything near ampullaceous, occurring mainly near the pore-mouths, numerous; *trama* truly bilateral, of the *Boletus*-type, the mediostratum axillar, colored, its hyphae parallel-interwoven and densely arranged, the lateral stratum strongly and entirely divergent, hyaline, and loosely arranged; structure of the *cuticle* very variable, sometimes a quite fragmentary palisade is present, and the uppermost layer of parts of the surface formed by irregular interlaced, melleous-yellow or yellow hyphae whose terminal members have rounded tips, while in other specimens the palisade is as uninterrupted and well developed as in *T. tabacinus* with the terminal members frequently assuming the character of dermatocystidia, often clavate or fusoid; all *hyphae* without clamp connections.

Chemical reactions.—KOH on context of pileus, yellow, eventually reaching "yellow ocher." — H_2SO_4 negative if applied before autoxydation takes place, bleaching the darkened portions if applied afterwards. — NH_4OH

15 In the type specimen of an unpublished species of Murrill's which he correctly identified as *T. peralbidus* in later notes, the spore print is "pale ochraceous buff." I do not believe that such pale tints occur in fresh spore prints; they are evidently the result of bleaching by drying out or while preserved.

negative, or intensifying or accelerating the autoxydation. — $FeSO_4$ on context, "dark Payne's gray" or "violet slate," or "light Varley's gray" (immediately and constantly so); if the gray spot is treated with KOH afterwards. it becomes red. — Formol on context, as with ammonia. — Methylparamidophenol positive (purplish lilac) but slowly and not very strongly.

Habitat.—In woods and gardens, in high hammocks and on shaded lawns, on the ground, usually near *Quercus laurifolia,* but also near other oaks, and occasionally also under pines (*Pinus australis*). Fruiting from May till October.

Distribution.—Florida, but not in South Florida.

Material studied.—FLORIDA, ALACHUA CO., Gainesville, *Murrill, F 15871* (FLAS), also one collection at FH; *Singer F 1991, F 1991 a* (FH); *F 1970, F 1970 a, F 1970 b* (FH); *F 2124, F 2124 a* (FH); *F 2685* (FH) and numerous other fresh collections of the author.

This has been described and labeled under a different name by Murrill but the name was never published because Murrill realized that this was identical with what Snell and Beardslee had described as *Boletus peralbidus.* We have not seen the types of *B. peralbidus,* but we have seen a letter from Snell to Murrill in which the former says he has compared his type with what Murrill had sent him (F 15871) and "they match the type perfectly." The name *T. peralbidus* is regrettable because this plant is not typically "all whitish."

The color of the spores and the color of the pileus are somewhat variable. We have described the most common form of this common fungus as var. *typicus,* and now we have to add two aberrant forms, one of which we consider as a remarkable color form while the other seems to be more than that and is here given as a variety.

Forma **praeanisatus** (Murr.) Sing. comb. nov.

Gyroporus praeanisatus Murr., Lloydia **6**:225. 1943.
Boletus praeanisatus Murr., Lloydia **6**:228. 1943.

Pileus partly or entirely umber or fuliginous; taste more decidedly bitter than in most individuals of the type form; odor "strong of anise" (Murrill), slight and fruity or none in our specimens; otherwise like the type.

Habitat.—Under oaks (*Quercus laurifolia*) on the ground. Fruiting from June until August. Rare.

Distribution.—North Florida.

Material studied.—FLORIDA, ALACHUA CO., TYPE of *G. praeanisatus* (FLAS) and AUTHENTIC material (FLAS); *Singer, F 2708* (FH).

Var. RHODOCONIUS Sing., Mycologia **37**:799. 1945.

Spores (9.7)-10.5-13.5-(17.3) x 3-3.5μ, pale melleous, smooth, cylindric to cylindric-clavate (slightly thicker at the base or in the basal third), pinkish ("vinaceous fawn") in print; *basidia* 27.5-29.2 x 8μ; *cystidia* 36-45 x 6-8.5μ, ventricose, the apex ampullaceous as in *Leccinum* with a neck of variable

length, hyaline, or a few of them with melleous-incrusted necks, scattered in the tubes, numerous on pores; otherwise like var. *typicus* f. *praeanisatus*.

This variety is rare in Florida, and differs from the type form not only in the more umber pileus but also in pinkish spore print and perhaps more ampullaceous cystidia. It is possible that this will ultimately be considered as a closely related but different species.

Extralimital Species

Tylopilus Balloui (Peck) Sing. comb. nov.

Boletus Balloui Peck, Bull. N. Y. State Mus. **157**:22. 1912.
Gyrodon Balloui Snell, Mycologia **33**:422. 1941.
Boletus subsanguineus Peck *sensu* (Murr.) Coker & Beers, Bol. N. Car., p. 23. 1943; an Peck (1900).

This species is obviously a *Tylopilus*. The short spores do, in fact, occur in almost all groups of boletes and are not characteristic for *Gyrodon* alone. I have examined the type (NYS) and material determined by Murrill as *C. subsanguineus* (Peck) Murr. (NY). I find the spores 7.5-11 x 3.7-4.8μ, ellipsoid-ovoid to short-cylindric, the larger ones clavate with the basal portion thicker than the central one, in an average about twice as long as broad, hyaline with a slight yellowish sheen in most of them, thin-walled, smooth; basidia 27-27.5 x 8.3μ, 4-spored; cystidia 34-78 x 6.5-16.5μ, ventricose-fusoid, with or without a 1-11μ long mucro, very few hyaline or subhyaline, the majority strikingly dark golden yellow incrusted and easily recognizable under low power as deep yellow spots on hyaline ground; trama of the hymenophore truly bilateral, of the *Boletus*-type, the lateral stratum consisting of much thicker hyphae (2.7-8.2μ in diameter) than those of the mediostratum (2-4.5μ) and almost hyaline, very slightly but undoubtedly and entirely divergent, loosely arranged; the mediostratum slightly more decidedly colored, denser, subinterwoven, axillar, thin in comparison with the lateral stratum; subhymenium very distinct, of intricately interwoven, very thin filamentous hyphae; cuticle of very irregular, partly erect, colored (golden-succineous) filamentous hyphae which are partly in strands, and have obtusely rounded tips at their free ends; hyphae of the context hyaline, all hyphae without clamp connections.

The naming of this well characterized species is one of the most intricate nomenclatorial problems I have ever encountered in so-called American species. Murrill has (before *B. Balloui* had been published) called this *Ceriomyces subsanguineus*, and Coker & Beers follow his lead in 1943, while Snell and this writer prefer the later but inequivocal name *B. Balloui*. There is absolutely no doubt that this species is *B. Balloui;* the types are in excellent condition and well described. On the other hand, there is no type of *B. subsanguineus* preserved at Albany. This species was known to Peck from a picture only, or if there have been specimens they must have been lost. The description is somewhat vague and may well be interpreted as the same as *B. Balloui* if McIlvaine's picture which may be the original one sent to Peck, is compared. This picture may, however, also be something else, and besides there is no proof that it really represents the original picture which might

be regarded as a substitute for the type specimen. In favor of the name *B. subsanguineus* we may only say that Murrill has created something like a tradition of calling what certainly is *B. Balloui* by the dubious name *B. subsanguineus*. But this tradition, if we may call it so, is in my opinion, more than offset by the fact that there are, at Albany, authentic specimens—the only specimens preserved there under the name of *B. subsanguineus*—which most certainly are not *B. Balloui* and not even a *Tylopilus* at all but some *Boletus* of the section *Luridi*, probably close to *B. miniatoolivaceus*. This does not prove anything except the vagueness of Peck's own concept of *B. subsanguineus*.

My material shows that *T. Balloui* occupies an area from New York to North Carolina with the western limits unknown. *T. Balloui* is somewhat similar to certain specimens of *T. peralbidus*, even in color. Fortunately, they do not occur in the same territory together, and herbarium specimens can easily be distinguished by simple measurements of the breadth of the spores.

Tylopilus veluticeps (Pat. & Baker) Sing. comb. nov.

Boletus veluticeps Pat. & Baker, Journ. Straits Branch R. A. Soc. **78**:71. 1918.

The habit of the Singapore type (FH) is that of a slender form of *Tylopilus;* the spores are short ellipsoid with an indistinct suprahilar depression or applanation, the inner profile strongly convex otherwise, the upper half attenuate, very pale melleous, almost hyaline, thin-walled and smooth, 7.5-8.7 x 3.5-4.5μ; basidia 16-27 x 7-8.5μ; cystidia fusoid to vesiculose with subampullaceous apex or with a long filiform proliferation instead, 27-45 x 7-10.5μ, with finely granulose contents in the type specimens; cuticle consisting of erect chains of thick-walled (walls 1-1.5μ in diameter) short-ventricose hyphae or spherocysts, some of the chains terminating with a narrower appendage which is either cylindric or subulate with rounded tip; the surface appearing velvety and unbroken. The margin of the pileus is sterile and projecting (but probably not always since this is not shown in the sketch accompanying the type specimens); the pores are unequal in size but rather small in average, depressed around the stipe. All these facts are no doubt enough evidence to necessitate a transfer to *Tylopilus*.

Tylopilus cellulosus, spec. nov.

Pileo atrofusco, lato, subtomentoso; cuticula ex epithelio consistente; tubulis rubido-fuscidulis, exiguis; sporis in cumulo cacaocoloribus, sub microscopio melleis et 10.5-12.5 x 4-5.5μ; cystidiis fuscis, clavato-acutatis, 40 x 7.5-10.5μ; stipite griseolo-bruneo, subtomentoso, torto, 150 x 12 mm.; carne dilute coriaceo-brunnea brunneoque marmorata; hyphis haud fibuligeris.

Pileus dark brown, suède (subtomentose), convex, about 110 mm. broad. — *Hymenophore* chocolate brown, watery, soft, depressed around the stipe; tubes 13-14 mm. long; pores subconcolorous, small 10 to 15 mm.; spore print "pinkish cinnamon" with a shade of "fawn color" (two years old). — *Stipe* gray brown, suède (subtomentose), tortuous, rather hard, solid, slightly tapering upwards, almost equal, about 150 mm. long and 12 mm. thick at the apex

to 20 mm. thick at the base. — *Context* light tan color (from the beginning ?), mottled or striped with brown, soft in the pileus; odor and taste not noted.

Spores 10.5-12.5 x 4-5.5μ, pale melleous, smooth, subfusiform; *basidia* about 28μ long and 7-9.5μ broad; *cystidia* about 40μ long and 7.5-10.5μ broad, clavate to clavate-fusoid but always with acuminate tip, brown; *trama* of the hymenophore not clearly definable in this material (too mature); *cuticle* consisting of brown spherocysts (also some clavate bodies), *e.g.* 20 x 15μ; all *hyphae* without clamp connections.

Chemical reactions not studied.

Habitat.—In tropical woods on humus, solitary during the early rains (April).

Distribution.—Known only from the type locality, Nengbe, Liberia, Tropical West Africa, *G. W. Harley, 60* (FH).

This appears to be very easily recognizable and distinct. Tropical species with similar colors are *B. ater* Henn. from Cameroun and *B. funerarius* Mass. from Singapore. Both have much wider pores.

Tylopilus nigricans (Pat & Baker) Sing. comb. nov.

Boletus nigricans Pat. & Baker, Journ. Straits Branch R. A. Soc. **78**:70. 1918.

The type from Singapore (FH) is very close to *T. alboater* (Peck) Murr. We find the spores pale brown, 10.8-14 x 3.8-4.5μ; cystidia pallid to brownish, same shape as in *T. cellulosus* Sing., 28-42 x 7-14μ; trama probably truly bilateral of the *Boletus*-type, of *e.g.* 7μ broad hyphae, some of which now show spiralling veins (mucose or resinous ?); the cuticle of the pileus and stipe consists of a palisade of clavate or more rarely ampullaceous-fusoid light to dark brown hairs with rather thick (0.7μ), brittle walls, about 4μ in diameter; all hyphae without clamp connections.

This analysis shows that this plant differs from *T. alboater* only in the shape of the cystidia and spores and probably in the smaller size of the carpophores.

Tylopilus ferrugineus (Frost) Sing. comb. nov.

Boletus ferrugineus Frost, Bull. Buff. Soc. Nat. Sc. **2**:104. 1874. *non* Schaeff. *ex* Bres. (1931).

We have seen good material (FH, NY) and have compared it with the type material and authentic collections of Frost. As for our Florida species, this is no doubt closest to *T. tabacinus* (Peck) Sing., especially to *T. tabacinus* var. *dubius* Sing. Since in this group so many species have been described, all hardly distinguishable to me, and since it may be confused with Florida species, and possibly be found in Florida in the future, we shall add a complete description of this species.

Pileus "sayal brown," "Verona brown," "snuff brown," but somewhat variable within the limits of what may be called reddish brown, not much changing color in drying, non-viscid, sometimes with a yellowish bloom towards the margin which is due to fugacious accumulations of dermatocystidia, this bloom disappearing in age and on drying, subglabrous, or minutely tomentose,

pulvinate, then convex and often somewhat irregular with wavy or somewhat lobed margin, with slightly projecting sterile or entirely fertile margin, 45-100-(145) mm. broad. — *Hymenophore* whitish when quite young, light flesh color, becoming brown when bruised, adnate, soon depressed around the stipe; tubes 7-11 mm. long, rarely longer; pores concolorous, staining brown on pressure, small, rounded-angular, 6-14 to 5 mm.; spore print somewhere between "Isabella color" and "wood brown" (not quite fresh). — *Stipe* "cream buff" masked with "snuff brown," or subconcolorous with the pileus below and paler above, either smooth or with a reticulation of very irregular and inconstant extent and density, usually the upper third or quarter of the length of the stipe reticulated but in some specimens of th same collection the reticulation extending over one half to three quarters of the stipe's length, the meshes longitudinally elongate, usually smaller than in *T. tabacinus*, the surface outside the network subglabrous to minutely flocculoso on paler ground, rather versiform, tapering upwards or downwards, or subequal, sometimes compressed longitudinally or otherwise irregular, even slightly eccentric, solid, 35-80 x 15-25-(33) mm. — *Context* white in fresh and young specimens first changing to pink when bruised, then becoming brown in the wounds, rather firm and thick in the pileus, but soon becoming soft; taste mild; odor none.

Spores 8.3-13 x (3)-3.5-5μ, hyaline, soon becoming pale yellow on maturing and some with a brownish melleous shade, thin-walled, very few with slightly thickened walls, smooth, ellipsoid-subfusoid, some clavate and tapering upwards; *basidia* 22-29 x 7-10μ, 4-spored; *cystidia* 30-50 x 5.5-12.5μ, with golden yellow contents, yellow granulose, or yellow incrusted, strongly contrasting with the hyaline background, fusoid, clavate, or ampullaceous, the majority obtusate but many of them more or less acute at the tip; *trama* of the hymenophore truly bilateral of the *Boletus*-type;; cuticle of the pileus and the floccons of the stipe formed by short but not brittle, yellowish to castaneous-fulvous, more rarely hyaline, thick-walled hairs as in *T. alboater;* among them numerous dermatocystidia as in the hymenial layer of the hymenophore, these hairs and dermatocystidia together forming the palisade of the pileus respectively the fascicles of the floccons of the stipe; the dermatocystidia usually scarce on the pileus but numerous on the stipe; all *hyphae* without clamp connections.

Chemical reactions unknown.

Habitat.—In woods, usually under oaks, fruiting from July till September.

Distribution.—From New England to Georgia and westwards (western limits unknown), possibly entering North Florida.

Material studied.—VERMONT, TYPE (?) and AUTHENTIC material (FH). MASSACHUSETTS, Canton, several collections, *Linder* (as *T. indecisus*) (FH); Middlesex Falls and Cabot's Woods, *Farlow* (FH). VIRGINIA, Mountain Lake, *Linder & Snell* (det. Snell as *B. indecisus*) (FH). GEORGIA, Glenbrook Ravine, vicinity of Tallulah Falls, Aug. 12, 1901, *Seymour* (det. *Singer*), (FH), also probably two more collections (*Seymour, 14. 15.*)

Snell discards Frost's species with the implication that it is antedated by *Boletus ferrugineus* Schaeffer. The latter is, however, pre-Friesian and has not been validated, as far as I know, by any post-Friesian author until Bresadola

took it up in the sense of *Xerocomus spadiceus* (Fr. *sensu*) Quél. I can see no reason why Frost's name should be rejected unless an application of Schaeffer's name between 1821 and 1931 has escaped my attention.

Frost says that the flesh is unchanging but he probably overlooked the autoxydation which is slow and not very distinct in the first phase; it is lacking in not quite freshly collected material. His description covers the darker forms of this species, but some of his authentic specimens are as light colored as any of the above cited material. The following species may be mere synonyms of this:

Boletus decorus Frost, Bull. Buff. Soc. Nat. Sc. 2:103. 1874.

This has been considered as a form of *B. edulis* but since Snell says it rather belongs in this group, it may turn out to be identical with *T. ferrugineus*.

Tylopilus indecisus (Peck, Rep. N. Y. State Mus. 41:76. 1888) Murr., Mycologia 1:15. 1909.

This is said to have ochraceous brown pileus; besides, Peck thought that *T. ferrugineus* had no "pink" spores. Since it does have "pink" spores (obviously the same tinge that Peck calls brownish flesh color which is descriptive enough for *T. ferrugineus*), and the pileus varies from lighter to darker shades of reddish brown, we can see no reason why *T. indecisus* should be different from *T. ferrugineus*. In fact, the type (NYS) is indistinguishable from *T. ferrugineus* and shows the same variable extent (or absence in some specimens) of the reticulation of the stipe. There seems to be a tendency to determine mild or submild forms of *T. felleus* as *T. indecisus*. Peck's specimens as well as his description definitely exclude this possibility. Most of our material of *T. ferrugineus* had been determined *B. indecisus*.

Boletus subpunctipes Peck, Bull. N. Y. State Mus. 116:19. 1907.

The type (NY) is not, as Murrill thought, the same as *T. felleus*, but obviously a specimen of *T. ferrugineus* with entirely non-reticulated stipe. The color of the pileus is perhaps somewhat more cinnamon and the surface is less velutinous than in the types of *B. indecisus*.

Boletus subdecorus Snell, Mycologia 28:21. 1936.

Here, the spores are somewhat larger than usual in *T. ferrugineus;* yet, it is hard to believe that this should belong to the section *Edules* of *Boletus* rather than in the closest neighborhood of *T. ferrugineus*. I have seen no specimens.

Boletus pseudodecorus Snell, Mycologia 28:22. 1936.

Snell thinks now that this is *T. ferrugineus* (Frost) Sing. with which it coincides in every particular.

Tylopilus eximius (Peck) Sing. comb. nov.

Boletus eximius Peck, Journ. Mycology **3**:54. 1887.
Boletus robustus Frost, Bull. Buff. Soc. Nat. Sc. **2**:104. 1874, *non* Fr. (1851).
Boletus scabripes Peck, Bull. Torr. Bot. Cl. **29**:555. 1902.

This northeastern species has been collected by the writer in fresh condition and has also been compared with the respective Peck types (NYS) and authentic material of *B. robustus* (FH). The spores are characteristically large and narrow, pale brown, smooth, 13.5-23.5 x 3.5-5.5μ; basidia (23)-26-30 x (5.2)-7.8-9μ, 4-spored; cystidia hyaline, narrow, infrequent, ventricose or clavate-acuminate, 14-28 x 6-10μ; trichodermium of the cuticle not in palisade, the terminal members of the filamentous hyphae cylindric or clavate with broadly rounded tips, brown; cuticle of the stipe little differentiated except for the flocculae which consist of strands of parallel hyphae ending in fascicles of hymenium with about 25 x 5μ large dermatobasidia and versiform, often brown, 20-40 x 6-10μ large dermatocystidia. The spore print when fresh is deep ferruginous ("amber brown"). *T. eximius* reaches Georgia in the south but has not been observed in Florida.

Species Imperfectly Known and Species Incertae Sedis

TYLOPILUS JAVANICUS Henn. Monsunia **1**:146. 1899.

I have not seen specimens. It may be close to the following species.

GYROPORUS JAMAICENSIS Murr., see part II, Farlowia **2**:240. 1945

BOLETUS MODESTUS Peck, Ann. Rep. N. Y. State Mus. **25**:81. 1873.

Though I have seen the type (NYS), I am not quite sure about the position of this species. I do not think, however, that it is a mere synonym of *T. felleus* as suggested by Murrill.

CERIOMYCES ALACHUANUS Murr., Mycologia **30**:522. 1938.

Pileus uniformly bay-fulvous, slightly viscid when moist, glabrous, smooth, convex, 30 mm. broad. — *Hymenophore* pale yellowish, unchanged when cut; pores small, not stuffed when young. — *Stipe* subconcolorous but streaked, not reticulate, smooth, dry, solid, tapering downwards, 40 x 10 mm. — *Context* white, becoming very slightly pinkish when cut, firm; taste mild; odor not recorded.

Spores 10-12.3 x 3.5-4.5μ, clavate with the thickest portion near the base, nearly hyaline with a slight melleous shade; *hyphae* without clamp connections.

Chemical reactions unknown.

Habitat.—On the ground in a hammock, January.

Distribution.—Known only from a single specimen from the type locality.

Material studied.—FLORIDA, ALACHUA CO., south of Newnan's Lake, *Murrill, F 15860* (FLAS).

This species is here described from the data published by Murrill and my microscopical examination of the type. The tubes appear now to be depressed around the stipe; the surface of the pileus is glabrous, subtomentose on the

margin, brownish with a slight olivaceous tinge. In the fresh condition the apex of the stipe is said to be pale yellowish. The trama is probably truly bilateral but I was not sure of it. It belongs most probably in *Tylopilus*, and possibly in the *T. ferrugineus*-group. More data from more numerous collections are needed to make a transfer safe.

BOLETUS INDECORUS Mass., Bull. Bot. Gard. Kew **1914**:75. 1914.

A portion of the type (FH) shows the spores to be ellipsoid with distinct suprahilar depression, with rather thick walls, smooth, melleous; hyphae of both the cuticle of the pileus and stipe filamentous, without clamp connections. This may or may not be a *Tylopilus*, but the above additional data on Massee's material may help to identify this plant when re-collected on the Malay Peninsula for observation of the now lacking data.

Species Excludendae

TYLOPILUS GRACILIS (Peck) Henn. This is *Porphyrellus gracilis* (Peck) Sing.
TYLOPILUS SUBFLAVIDUS Murr. This is *Porphyrellus subflavidus* (Murr.) Sing.

6(15). LECCINUM S. F. Gray, Nat. Arr. Brit. Pl. **1**:646. 1821. *em.* Snell, Mycologia **34**:406. 1942.

Krombholzia Karst., Rev. Mycol. **3**:17. 1881. (type *K. versipellis*) *non* Rupr. *ex* Galeotti, Bull. Acad. Bruxelles **9**:247. 1844, *nec Krombholtzia* Benth., Journ. Linn. Soc. **19**:121. 1881.
Trachypus Bat., Bolets, p. 12. 1908. (lecto-type proposed: *B. rufus*).
Krombholziella R. Maire, Publ. Inst. Botàn. Barcelona **3**(4):41. 1935 (type *K. aurantiaca*).

Characters of the genus: Pileus with a cuticle consisting of an epithelium or with only a few spherocysts, or with some chains of broad hyphae mixed in along with filamentous hyphae of the trichodermium, or the cuticle made up by a cutis consisting of filamentous, horizontally arranged hyphae only, viscid or dry, glabrous or tomentose, often rimulose, the margin often sterile and projecting and then sometimes looking like a spurious veil in young specimens; no true veil present in any species; hymenophore yellow or whitish, convex beneath, the tubes very long but drastically depressed around the stipe; pores always very small and far below 1 mm. in diameter, concolorous with the tubes; spores in print olivaceous-umber to umber, or, in one species (which does not occur in Florida) dirty vinaceous; trama truly bilateral of the *Boletus*-type, but forming a very thin layer and the lateral stratum soon stretched and parallel; cystidia fusoid-ventricose, very frequently with ampullaceous apex, hyaline, small to medium sized; stipe usually rather thin and fragile at the very apex in mature specimens, otherwise fibrous-hard and thickened downwards, beset with very prominent furfuraceous particles or dark squamules causing the stipe to appear and feel scabrous-rough, non-viscid, without glandulae and without reticulation except for occasional specimens in which the prominent dark scabrosities are connected with very fine lines forming a peculiar and usually not persistent network; scabrosities of the

stipe consisting of a strand of parallel hyphae which terminates in a fascicle of hymenium consisting of dermatobasidia, dermatopseudoparaphyses, and dermatocystidia; mycelium forming mycorrhiza with forest trees, almost constantly with species of the Salicales and Fagales (in Florida *Quercus*). The type species is *L. aurantiacum* (Bull. *ex*) S. F. Gray (*B. aurantiacus* Bull.).

The name *Leccinum* has been taken up by Snell though, in S. F. Gray's sense, it is a substitute for *Boletus* (which Gary reserves for *Polyporus*). However, the two first species in Gray's treatment happen to belong to *Leccinum sensu* Snell, and by choosing the first species as the type species, this genus can thus be emended and modernized, much to the advantage of bolete nomenclature. Though the word *Leccinum* is derived from the Italian *leccino,* a common name probably referring to *Suillus granulatus,* Snell's proposal is apt to ease a confused situation since *Kromholzia* has been spelled erroneously, I suppose, the same way as our fungus genus, by those who in 1844 introduced it for phanerogames, and the spelling *Krombholtzia* for this genus is not found until 1881. *Trachypus* and *Krombholziella* have not come into general use thus far. Since Snell established the type species of *Leccinum* in a comprehensive paper and as a competent specialist, I feel that Gray's genus has to be accepted in Snell's sense, which automatically makes all the other names later synonyms.

The diagnosis given above makes it possible to fix the limit between *Boletus* and *Leccinum* in such a way as to incorporate into *Leccinum* those species that have a transitory covering of the stipe (such as *L. subglabripes*), if because of natural affinity and other prominent characters they are obviously better taken care of within *Leccinum* than within *Boletus.* Species with an epithelium are taken into *Leccinum* if their characters otherwise fit into this genus.

Morphologically speaking, the scabrosities of *Leccinum* are homologous with the glands of *Suillus* and the minute floccons of the *Boletus* and *Xerocomus* and represent nothing but a modification of the ordinary reticulation of many species in *Pulveroboletus, Xerocomus, Boletus, Tylopilus* which in its turn is merely a continuation of the hymenophore in a reduced way over a normally sterile portion of the carpophore, the stipe. In certain young specimens of *Boletus inedulis, Suillus cembrae,* and *Leccinum aurantiacum* the homology between floccons, glands and scabrosities on one hand and the primordial reticulation is still well recognizable since in all these species the floccons, glandulae, or scabrosities are initially connected by lines, thus forming a reticulation; later the connecting lines disappear and the floccons, glandulae, scabrosities remain. In most species the reticulation cannot be demonstrated any more once it is replaced by isolated floccons, glandulae, or scabrosities. Naturally, this morphological affinity of the various ornamentations of the stipe does not make them any less useful as generic or specific characters in the Boletaceae.

KEY TO THE SECTIONS

A. Hymenophore more or less yellow ..... Section *Luteoscabra*
A. Hymenophore initially white or whitish, then becoming more or less sordid but not yellow.

B. Spores in print umber or olive-umber; stipe never deep chrome; pileus never pink ..... Section *Versipelles*
B. Spores in print cinnamon or brownish with a vinaceous hue; stipe deep chrome at the base; pileus pink ..... Section *Roseoscabra*

Section **Luteoscabra** Sing. sect. nov.

Hymnophoro et plerumque stipite et parte carnis flavo-tincto.

Characters of the section: see key and Latin diagnosis. Type species: *L. nigrescens* (Rich. & Roze) Sing. (*Boletus nigrescens* Richon & Roze).

This section is, of the three known sections of *Leccinum*, the one nearest to *Boletus*, as has been emphasized previously by R. Maire (1935).

KEY TO THE SPECIES

A. Outermost layer of the cuticle of the pileus (epicutis) formed by an epithelium or by erect chains of short, broad hyphae; pileus non-viscid.
B. Context unchanging on injury except for a slight reddening that takes place with age and only in certain portions of the context, rarely turning blue either in the pileus or in the stipe ..... 36. *L. subglabripes*
B. Context distinctly changing color immediately on injury (becoming dirty vinaceous violet or drab, pinkish gray or pinkish red, etc.) but not bluing.
C. American species with the hymenophore dull yellow, never lemon yellow ..... 37. *L. rugosiceps*
C. European species with bright yellow, lemon yellow hymenophore .... *L. nigrescens*
A. Outermost layer of the cuticle of the pileus formed by the cutis which consists of cinnamon-castaneous filamentous hyphae which are very flexuous and loosely arranged in a gelatinous mass; pileus viscid ..... *L. rubropunctum*

Description of the Species Occurring in Florida

36. LECCINUM SUBGLABRIPES (Peck) Sing., Mycologia **37**:799. 1945.

Boletus flavipes Peck, Rep. N. Y. State Mus. **39**:42. 1886, *non* Berk. (1854).
Boletus subglabripes Peck, Bull. N. Y. State Mus. **8**:112. 1889.
Suillus subglabripes Kuntze, Rev. Gen. Pl. **3**(2):536. 1898.
Ceriomyces subglabripes Murr., Mycologia **1**:153. 1909.
Krombholzia subscabripes Sing, Rev. de Mycol. **3**:188. 1938.
?*Boletus unicolor* Frost *apud* Tuckerman & Frost (1875) *nom. nud.; apud* Peck, Bull. N. Y. State Mus. **8**:100. 1889.
?*Suillus unicolor* Kuntze, Rev. Gen. Pl. **3**(2):536. 1898.

Description of the Florida Collections

Pileus "auburn" with a tinge of "chestnut," or between "bay" and "chestnut," sometimes deeper colored than these, smooth or slightly rugulose, non-viscid, convex, 37-78 mm. broad. — *Hymenophore* a vivid rich golden yellow when young (between "citron yellow" and "strontian yellow") becoming as greenish as "yellowish citrine," tubes up to 10 mm. long, deeply depressed around the stipe; pores small, concolorous and usually unchanging but very rarely bluing on pressure; spore print "buffy olive." — *Stipe* "strontian yellow" at the apex and "mustard yellow" to "chamois" or concolorous with the apex farther downwards, later here and there with a tinge of "cacao brown," or with "onion skin pink" to "buff pink" in the middle, with concolorous or

slightly darker scabrosities consisting of furfuraceous, small squamulae, the base often curved, tapering from the base or from the middle upwards, in the latter case also tapering from the middle downwards, more rarely tapering from the apex downwards, 50-68 x 8-15 mm. — *Context* light yellow in the pileus and there sometimes bluing but mostly unchanging everywhere, concolorous with the surface in the stipe and there almost always unchanging, very rarely bluing, soft and fleshy in the pileus, becoming spongy and watery, hard and fibrous in the stipe, becoming fragile; odor none; taste mild.

Spores 13-18.5-(20.5) x 5-6μ, melleous or pale melleous, fusoid or ellipsoid-fusoid with suprahilar depression; *basidia* 23-34 x 11-12.5μ, 4-spored, rarely a few 2-3-spored; *cystidia* hyaline, ventricose in the middle, with an ampullaceous apex, rather numerous near the pores, 27-48 x 6.5-15μ; *trama* truly bilateral, of the *Boletus*-type; cuticle forming erect chains of spherocysts, the latter about 13.5-26.5μ in diameter, forming an epithelium; scabrosities of the stipe formed by strands of parallel, cylindric, hyaline hyphae, projecting above the surface of the stipe and forming with their terminal members a large fascicle of hymenium, consisting of bodies differentiated as dermatobasidia (28-29 x 9-12μ, 4-sterigmatic), dermatopseudoparaphyses (hyaline, or yellowish, versiform, even sometimes 2-3-lobed, often with appendage, representing the most numerous element, 20-50 x 11-19μ), and dermatocystidia (cylindric, fusoid, vesiculose with ampullaceous apex, hyaline, 34-55 x 8-15μ); all *hyphae* with calmp connections.

Chemical reactions not studied.

Habitat.—Under oaks in high and mesophytic hammocks, solitary or in small groups on the ground. Fruiting from June till August.

Distribution.—Florida and, if identical with the northern collections, north to Canada, if a separate form or race, at least to North Carolina.

Material studied.—FLORIDA, ALACHUA CO., Gainesville, *Singer, F 2519, F 2519 c* (FH); Sugarfoot Hammock, *Singer, F 2519 a, F 2519 b* (FH); Newnan's Lake, *Singer, F 2636* (FH).

Description of the Northern Collections

Pileus "naphthalene yellow" and "antimony yellow" and "buckthorn brown" and "ochraceous tawny," all these colors varying in extent, sometimes with "Mikado brown" spots, sometimes one or two of the above colors lacking, opaque, non-viscid, even in rainy weather, with a very slightly projecting sterile margin, glabrous, smooth, or subsmooth, convex, up to 66 mm. broad. — *Hymenophore* between "citron yellow" and "strontian yellow," becoming as greenish as "sulphine yellow" when old, plane, becoming convex beneath, depressed around the stipe; tubes fairly long; pores very small; spore print "Saccardo's olive." — *Stipe* "naphthalene yellow" or lighter colored (to "citron yellow"), or with "wax yellow" stains, or with slight to strong "Pompeian red" or "madder brown" or "brick red" spots or stripes, straight or more often somewhat flexuous, equal or with tapering base, transversely furfuraceous-squamulose-scabrous, the scabrosities concolorous with the ground color, solid, 80-95 x 8-14 mm. — *Context* light yellow, mixed with some

deeper lemon yellow, or often with some red like that on the surface of the stipe, but the context of the pileus uniformly light yellow, rarely with reddish spots when old, and then distinctly bluing on injury (var. *caerulescens* Sing. in sched.), not otherwise changing color when bruised; odor almost none; taste mild.

Spores 10-20 x 3.5-5μ, most frequently 13-14 x 3.7-4.2μ, melleous to pale melleous, fusoid-ellipsoid to subfusoid with suprahilar depression; *basidia, cystidia, trama, cuticle* and *scabrosities* of the stipe as in the Florida specimens.

Chemical reactions.—KOH on the surface of the pileus, negative; on tubes, "chestnut." — NH_3 and NH_4OH everywhere negative or almost so. — $FeSO_4$ negative.

Habitat.—In mixed woods and in frondose woods under black or yellow birch and also under oak on the ground, usually gregarious. Fruiting from June until September.

Distribution.—From Eastern Canada through New England and New York, possibly also farther south and west.

Material studied.—NEW HAMPSHIRE, Jaffrey, *H. Webster* (det. Linder), (FH); Alstead, *Fernald* (FH). MASSACHUSETTS, Harvard, *Singer* and *Harrie Dadmun* (FH). ONTARIO, Bear Island, Lake Temagami, *Jackson, 7676* (FH); *Cain, 12009* (FH); Forest Belt, C.E.F., Ottawa, *Conners, 5927* (det. Snell) (FH). NEW YORK, Silver Lake Assembly, *F. H. Ames*, (NYS); Port Jefferson, AUTHENTIC (NYS); AUTHENTIC material of *B. flavipes* Peck *non Berk.* (possibly type?), (NYS).

We have given the description of the Florida specimens separately from that of the northern plant which we have found identical with Peck's material. The differences are mainly in the color which is a different shade in the pinkish or reddish stains in the flesh and on the surface of the stipe. The color of the surface of the pileus also is a different shade of brown in the Florida plant when compared with the northern form. It may be that our experience in spite of the numerous carpophores examined is too limited to evaluate the constancy of these different shades. Peck, in his original description says that the pileus is red or chestnut which would rather fit the Florida form if any. Curiously enough, the plates which were published by Peck (Rep. N. Y. State Mus. **51**, *pl. 55, figs. 1-7.* 1898, and Mem. N. Y. State Mus. **3**(4), *pl. 64, figs. 1-7.* 1900) show the pileus much more yellow, about the color some of the specimens still show and rather agreeing with the specimens I collected in Massachusetts. It has to be kept in mind that part of Peck's illustrations refer to his var. *corrugis* which is nothing but *L. rugosiceps.*

Another curious matter is the occasional occurrence of bluing specimens in both the Florida and the northern collections. In the latter, the only bluing specimens I have ever seen, grew near the normal specimens and were distinguished by the stipe which became more definitely red and the pileus that was subviscid after strong rains; the cuticle however, had the same structure as the non-bluing specimens, *i.e.* an epithelium. I can not, at present, decide whether this is a mutant, or a physiological stage.

Coker & Beers' *B. subglabripes* seems to be the same as the Florida form.

Peck and others have stated that *L. subglabripes* is edible.

Var. CORRUGATOIDES Sing., Mycologia **37**:799. 1945.

Pileus "light brownish olive," very rugose; spore print "light brownish olive." Microscopical and chemical characters as in the smooth type form from Florida.

Habitat.—In mesophytic hammocks with oak and *Magnolia grandiflora.*

Distribution.—From North Carolina to North Florida.

Material studied.—FLORIDA, ALACHUA CO., Kelley's Hammock, northwest of Gainesville, *Singer, F 2727*, TYPE (FH).

37. LECCINUM RUGOSICEPS (Peck) Sing., Mycologia **37**:799. 1945.

Boletus rugosiceps Peck, Bull. N. Y. State Mus. **94**:20. 1905.
Boletus subglabripes var. *corrugis* Peck, Bull. N. Y. State Mus. **2**(8):112. 1889.
Krombholzia rugosiceps Sing., Ann. Mycol. **40**:34. 1942.

Pileus "mustard yellow" near the margin and more ochraceous brown toward the disc, paler where cracked, non-viscid, subsmooth to rugulose or scrobiculate-pitted, then areolate-rimose, glabrous or subglabrous, pulvinate, then less convex and eventually often subplane, with projecting sterile margin, 62-150 mm. broad. — *Hymenophore* "pale green yellow" to "baryta yellow," deeply depressed around the stipe, convex beneath; tubes long to very long; pores small to very small, concolorous, somewhat sordid on pressure; spore print olive brown. — *Stipe* concolorous with the hymenophore, below "tawny"-scabrous on yellowish ground, the base and the mycelium "marguerite yellow," dry, solid, ventricose, 60-90 x 14-30 mm. — *Context* yellowish, slowly changing to dirty pinkish violaceous in fresh material (this may easily be overlooked on hasty observation), firm and fleshy, rather hard and fibrous in the stipe; odor nine; taste mild.

Spores 14-17 x 4.8-5.2μ, boat-shaped with rounded ends or ellipsoid-fusoid, with thin, rarely somewhat thickened walls, melleous; *basidia* 23-38 x 8-11.7μ, 4-spored; *cystidia* 33-40 x 4-10.5μ, fusoid-ventricose with the thickest part above the middle, the apex always forming an ampullaceous neck of 6-11μ length; *trama* with a bright yellow pigment easily diffusing in ammonia, truly bilateral of the *Boletus*-type, with somewhat colored, denser medio-stratum and hyaline, divergent, loosely arranged lateral stratum, the trama as a whole comparatively thin; *cuticle* of the pileus with an epithelium consisting of many layers of spherocysts which are arranged in erect chains and ending with a spherocyst or more frequently with a thick, subulate appendage-like mucro that is smaller than the next-lower member of the chain and is divided from it by a septum, or not divided from it; a minority of chains consists of mere successions of short-cylindric hyphae of 5-8μ diameter; the spherocysts are 9-33μ in diameter; some members with a more elliptical outline, *e.g.* 25 x 13.5μ; scabrosities of the stipe consisting of strands of parallel hyphae terminating in small convex hymenia which in their turn consist of dermatobasidia (27.5-52 x 8.5-11μ, 4-spored), dermatopseudoparaphyses versiform, often ventricose-subclavate, often with 1-4 sterigma-like appendages, hyaline or faintly yellowish, 27-70 x 9.5-21μ, and dermatocystidia in shape like those of the hymenophore but often lower portion broader, hyaline or faintly yellowish, 39-68 x 6.8-15μ; the hyphae immediately beneath the hymeni-

al elements of the scabrosities of the stipe forming some kind of a subhymenium, differentiated by being shorter than the other hyphae; all *hyphae* without clamp connections.

Chemical reactions.—KOH on context and tubes, intensely deep golden yellow to golden ferruginous. — NH_3 little reaction. — $FeSO_4$ on context and tubes, greenish gray or grayish olive. — Formol on context, slightly reddish to strikingly salmon red.

Habitat.—On the ground under oaks and possibly also other frondose trees of the order Fagales, in Florida preferring gardens and shaded lawns to dense hammocks, gregarious. Fruiting from May till August, or perhaps until fall.

Distribution.—From New York to North Florida and some distance west (exact limits not known); very common in North Florida, increasingly less common towards the north.

Material studied.—FLORIDA, ALACHUA CO. Many times in and around Gainesville in spring and summer 1943, *Singer, F 1972, F 1972 a* (FH). NEW YORK, TYPES of *B. rugosiceps* and *B. subglabripes* var. *corrugis* (NYS).

This species differs from the preceding one in somewhat different colors of the pileus and especially of the tubes and pores, in somewhat larger size, and in changing context. This latter, the decisive character, also finds its expression in a marked difference in the chemical reactions (see *L. subglabripes,* northern collections) which is parallel to those of the unchanging and changing species of section *Versipelles.*

Peck's *Boletus subglabripes* var. *corrugis,* and Murrill's *Ceriomyces subglabripes,* Mycologia 5, pl. 80, *fig. 6,* 1913 as well as in Florida Boletes (1942) is also this species. Murrill says he also collected it in Putnam, Columbia and Clay Counties, Fla. This is also *Boletus rimosellus* Peck in the sense of Coker & Beers. However, the original description of Peck's is all but convincing. The only specimen found at Albany was collected by S. E. Wilkox in Washington, D. C. It is a *Boletus,* not a *Leccinum,* and probably belongs to sect. *Edules.* The type has been lost. On the other hand, the type of *L. rugosiceps* has been preserved. The type as well as two authentic collections are undoubtedly the *Leccinum* described above. Only one authentic specimen of *L. rugosiceps* from Wading River, Suffolk Co., N. Y., Aug. 21, 1906, is *L. rubropunctum.* Peck seems to have distinguished *L. rugosiceps* and *L. subglabripes* mainly by the degree of scabrosity to be seen on the stipe. This, however, is a variable character in both species, and certainly of secondary importance, except perhaps for certain local populations. The less distinctly scaly specimens with rugose cap have been referred to *B. subglabripes* var. *corrugis* by Peck while the strongly scabrous specimens with rugose caps were referred to *B. rugosiceps.*

This species has been tested by several authors, including the writer, and found to be of good edible quality. Considering its abundance in summer in North Florida, one may strongly recommend it for use in the kitchen.

Extralimital Species

Leccinum nigrescens (Rich. & Roze) Sing. comb. nov.

Boletus tesselatus Gill., Champ. Fr., Hymen., p. 636. 1878, *non* Rostkov. *in Sturm* (1844).

Boletus nigrescens Richon & Roze, Atlas Champ., p. 191. 1888, *non* Pallas, Voyage Emp. Russ. **1**:31. 1788.
Gyroporus scaber var. *flavescens* Quél., Assoc. fr. avanc. sc. **1889**:512. 1889.
Boletus luteoporus Bouchinot *apud* Barb., Bull. Soc. Myc. Fr. **20**:92. 1904.
Boletus Velenovskyi Smotlacha, Vestn. k. ceské spol. náuk, **2**:60. 1911.
Krombholzia tesselata R. Maire, Publ. Junta Ciènc. Nat. Barcelona, Fungi Catalaunici, p. 42. 1933.
Krombholzia luteopora Sing., Rev. de Mycol. **3**:153. 1938.
?*Boletus crokipodius* Let., Fig. Champ., *pl. 666*. 1838, *nom. nud.*
?*Boletus rimosus* Vent. Mic. Agr. Bresc., p. 48. 1863.
?*Boletus cruentus* Vent., Mic. Agr. Bresc., p. 37. 1863.

This European species has been well described and figured in Kallenbach's *Pilze Miteleuropas* **1**(4):17, *pl. 7*. 1927. under the name of *Boletus rimosus*. We agree with the French mycologists who contend that Kallenbach's interpretation of *B. rimosus* and *B. cruentus* is impossible to prove and that these species are legitimately referred to as *nomina dubia*. While a certain kinship with *L. scabrum* cannot be denied, the white stipe in one and the blue stipe in the other species make it impossible to reject Richon & Roze's excellent account and figures in favor of Venturi's phantastic forms.

This is also the *Boletus radicans* of Rostkovius, but not that of Persoon. It is the *Boletus, Krombholzia, Trachypus* and *Krombholziella crokipodia* of some French authors. The writer preferred Bouchinot's name in 1938 but since *Boletus nigrescens* Pallas has apparently not been used in post-Friesian time, we feel justified in using the name of Richon & Roze.

We have collected this species at several occasions, and think it is sufficiently different from the three American species of this section. However, Romagnesi says that the cuticular hyphae are filamentous. In my specimens they were globulose-catenulate or at least very short as shown by Kallenbach. Romagnesi's observation suggests *L. rubropunctum* which thus far has not been indicated from Europe, or else he has examined specimens with the epithelium washed off.

Leccinum rubropunctum (Peck) Sing. comb. nov.

Boletus rubropunctus Peck, Rep. N. Y. State Maus. **50**:109. 1897.
Boletus longicurvipes Snell & A. H. Smith, Journ. Elisha Mitch. Soc. **56**:325. 1940.

I have seen good fresh and dried material from the following states: Massachusetts, New York, Virginia. There are also trustworthy reports from North Carolina and Georgia, and *B. longicurvipes* from Tennessee is apparently the same. It is therefore quite possible that this species occurs in North Florida though thus far it has not been collected.

The cuticle consists of repent but flexuous, loosely arranged, interwoven, filamentous hyphae with the terminal member clavate or equal at the end and slightly ascendant or more rarely horizontal but not forming anything like a palisade; very rarely these terminal members are ellipsoid or even subglobose, imbedded in a mucilaginous mass, in dried as well as in fresh material the section in NH_4OH is distinctly cinnamon; trama hyaline but lateral stratum appearing lighter under high power because of the loose arrangement of the divergent hyphae, the mediostratum scarcely pigmented but denser,

axillar, the hyphae subparallel-subinterwoven, trama as a whole very thin; all *hyphae* without clamp connections. The white context of our fresh collections becomes dark or pale gray with $FeSO_4$, and green with this same reagent in the base of the stipe.

Species Imperfectly Known

BOLETUS CORSICUS Rolland, Bull. Soc. Myc. Fr. **12**:1. 1896.

Boletus sardous Belli & Sacc., Bull. Soc. Bot. Ital. **1903**:225. 1903.
Boletus tlemcenensis R. Maire, Bull. Soc. Bot. Fr. **7**:CCXIV. 1907.

These are considered to be Mediterranean varieties of *Boletus impolitus* Fr. by R. Maire. The data about them strongly suggest varieties of *L. nigrescens* (Rich. & Roze) Sing., or rather a species closely related to this species. Maire later (1935) states that these boletes link the genus *Krombholziella* (=*Leccinum*) with *Tubiporus* (=*Boletus*). We do not need to rely on these forms alone to become convinced of the existence of a link between *Leccinum* and *Boletus*. The whole section *Luteoscabra* in general and *L. subglabripes* in particular may be considered as intermediate between *Boletus* and *Leccinum*.

As far as *B. corsicus* is concerned, we have to wait for more data in order to make sure that it is an autonomous species of *Leccinum* before we can propose a transfer under a new combination.

Section **Versipelles** (Fr. *emend.* Konr. & Maubl.) Sing. comb. nov.

Boletus, subgen. *Krombholzia*, sect. *Scabri* Konrad & Maublanc, Icon. Sel. **6**:459. 1926-1937.
Boletus, subgen. *Derminus*, sect. *Versipelles* Fr., Epicr., p. 423. 1838.
Boletus, subgen. *Krombholzia*, sect. *Versipelles* Konr. & Maubl., *l.c.*

This coincides with the limits of the genus *Leccinum sensu stricto* as initially understood by Snell. The characters are obvious from the key, p. 111-112. The type species is *Boletus versipellis* Fr. & Hök. (*i.e. L. aurantiacum*).

KEY TO THE SPECIES

A. Cuticle with a distinct epithelium, consisting of several layers of spherocysts, arranged in erect chains, and only a few chains of rather cylindric members, the spherocysts eventually isolated and no more catenulate but in this stage frequently washed or rubbed off.
  B. Context unchanging, pileus whitish or somewhat fuliginous, American species ..... 38. *L. albellum*
  B. Context strongly changing to reddish-violet-gray. European species ..*L. duriusculum*
A. Cuticle predominantly of filamentous hyphae even in the outermost layer but in some species arranged in chains with rather short members and even some spherocysts at places, but not prevalently cellular in a manner that could be characterized as epithelium-structure.
  C. Cuticle with chains containing (at least some of the chains) shortened hyphae or even some spherocysts, not yellow and not orange, and hyphae devoid of bright orange pigment under the microscope; associated with various species of *Betula*; context reddening by autoxydation when exposed .....*L. oxydabile*
  C Cuticle not formed by chains consisting of shortened hyphae or spherocysts; occasionally, there are very rare and very scattered spherocysts among the filamentous hyphae forming the uppermost layer of the pileus which is a felty

tomentum that easily becomes viscid in some species but then the color of the pileus is yellow or orange or rufous, and the context changes strongly when broken; if there are no spherocysts at all, not even isolated, scattered ones, the pileus may also be white, or avellaneous, or grayish brown, brown, fuscous, umber, blackish brown, etc., sometimes with some blue or green showing; the forms with unchanging context mostly under *Betula*, otherwise frequently with *Populus*, *Carpinus*, *Fagus*, or (in Florida always) with *Quercus*.

D. Pileus brown to grayish brown or umber, often with steel blue or caesious shades; context becoming reddish-violet-gray on injury; none of the colored hyphae of the cuticle filled with orange pigment; associated with *Quercus* in Florida ..... 39. *L. chalybaeum*

D. Pileus either not colored as indicated above (i.e. yellow, orange, reddish brown, or rufous, also white), *or* the colored hyphae of the cuticle (at least some of them) filled with a bright orange pigment, *or* the context unchanging. Rarely under *Quercus*, never found in Florida.

E. Context white, becoming either blue or reddish to violet to deep gray or black when bruised, eventually usually at least partially blackened; pileus yellow, orange, reddish brown or rufous, rarely whitish or white and then sometimes with a pinkish tinge.

F. Hyphae of the colored portions of the cuticle at least partly filled with bright and deep orange pigment; scales of the stipe whitish, then brownish and eventually blackish, often several of these colors present in different parts of the stipe; context rarely bluing; pileus rarely yellow and rarely orange red; mycelium associated with *Populus*, *Carpinus*, *Fagus*, or *Quercus* ..... *L. aurantiacum*

F. Hyphae of the cuticle never filled with bright, deep orange pigment; scales of the stipe black from the beginning; context rarely reddening, usually bluing on injury; pileus yellow or orange red; mycelium associated with various species of *Betula* ..... *L. testaceo-scabrum*

E. Context white, becoming very slightly pinkish (never violet nor eventually blackening), or slowly and slightly avellaneous-gray, or most frequently entirely unchanging on injury; pileus white, grayish brown, avellaneous, brown, fuscous, umber, etc. ..... *L. scabrum*

Description of the Species Occurring in Florida

38. LECCINUM ALBELLUM (Peck) Sing., Mycologia **37**:799. 1945.

Plate 1, Figs. 6 and 7

Boletus albellus Peck, Rep. N. Y. State Mus. **41**:77. 1888.
Ceriomyces albellus Murr., Mycologia **1**:145. 1909.

Pileus white, grayish white, or avellaneous-white, non-viscid, subpruinate, smooth, convex, the center becoming flat, 20-52 mm. broad. — *Hymenophore* white or very pale gray or grayish cream, depressed around the stipe; tubes 5-8 mm. long; pores regular and round or somewhat irregular, 0.4-0.8 mm. in diameter; spore print olive brown. — *Stipe* white to very pale gray, with the ground color always whitish but the scabrosities (which occasionally form a reticulate design) at times somewhat grayish, solid, slightly tapering upwards, very rarely slightly tapering towards the base, or subequal, 40-90 x 5-12 mm. — *Context* white, never yellow or blue anywhere in the carpophore, strictly unchanging, soft and fleshy in the pileus, harder and fibrous in the stipe; odor none; taste mild.

Spores 12.5-23 x 4.2-5.8-(6.5) μ, pale melleous-stramineous, thin-walled, a few with slightly thickened walls, smooth; *basidia* 24.5-30.8 x 10-13.5 μ, 4-spored; *cystidia* 38-55 x 6.5-9.5 μ, ventricose-fusoid with mucronate or ampul-

laceous apex, hyaline, numerous at least near the pores; *trama* thin but truly bilateral of the *Boletus*-type; *cuticle* with a well developed epithelium when young and fresh, the spherocysts organized in chains and some chains consisting of filamentous hyphae only, or with the terminal hyphae broadly clavate, but these filamentous hyphae only scattered and irregularly intermixed among the prevalently cellular epicuticular elements; the spherocysts hyaline, about 15-30μ in diameter; all *hyphae* without clamp connections.

Chemical reactions.—$FeSO_4$ on context, "dark violet gray" (a blackish gray). — Formol negative. — Phenol negative.

Habitat.—Under various species of *Quercus*, in Florida in high hammock vegetation, usually solitary or in small groups. Fruiting from June till September.

Distribution.—New York to North Florida and west to Missouri.

Material studied.—FLORIDA, ALACHUA CO., Kelley's Hammock, *Murrill* (as *B. niveus*), *F 20158* (FLAS); Sugarfoot Hammock, *Singer*, *F 2542* (FH). NEW YORK, TYPE and AUTHENTIC material (NYS). MISSOURI, Winora, *Routien*, *4158* (W. H. Snell Herbarium, Providence, R. I., as *Leccinum niveum*).

Forma **epiphaeum**, f. nov.

A typo pileo fuliginello differt.

Pileus "buffy olive" or "citrine drab," or brownish gray to sordid gray, or areolate-punctate in these colors on white ground because of early disruption of the cuticle under normal weather conditions, rimose-tessellate in old specimens, otherwise os the type form, 40-70 mm. broad. — *Hymenophore* grayish cream or gray, otherwise as the type form. — *Stipe* with umbrinous scabrosities all over on white to palest grayish ground, or fuliginous-scabrous only below, and the scales of the apex white, up to 15 mm. broad, otherwise as the type. — *Context* white, in the base of the stipe often faintly yellowish, otherwise as the type.

Microscopical and chemical characters as in the type form.

Habitat.—In high hammocks on the ground in small groups. Fruiting mostly in July.

Distribution.—North Florida.

Material studied.—FLORIDA, ALACHUA CO., Gainesville, *Murrill*, *F 19835* (as *B. niveus*) (FLAS); *Singer*, *F 2201* (FH); *F 2833* (FH).

Forma **reticulatum** Murr. f. nov.

A typo differt pileo reticulato.

Pileus white with a coarse reticulation almost all over its surface, the ridges colored grayish brown or rosy-isabelline, otherwise as the type. —*Stipe* white or pale gray, with white or pale gray scabrosities, otherwise as in the type. *Hymenophore* and *context* as in the type form.

Microscopical and chemical characters as in the type form.

Habitat.—In mesophytic and high hammocks, solitary or in small groups. Fruiting in June and July.

Distribution.—North Florida.

Material studied.—FLORIDA, ALACHUA CO., Gainesville, Murrill, TYPE (FLAS); Sugarfoot Hammock, *Singer*, *F 2534* (FH).

Murrill was not the only one to mistake *L. albellum* and its forms for *L. scabrum* and *L. scabrum* ssp. *niveum*. However, the author has studied the anatomy of the type specimens of *Boletus albellus* Peck and found that these are quite different in structure from the true *L. scabrum* and *L. scabrum* ssp. *niveum*. It is interesting to note that the characters of the boletes of the *Scaber*-group in Florida are exactly opposite to the corresponding species in Europe: *L. albellum* has unchanging flesh and cellular cuticle while *chalybaeum* has changing context and filamentous cuticle; in Europe, *L. scabrum* has unchanging flesh and filamentous cuticle, and *L. duriusculum* has changing flesh and cellular cuticle. *L. oxydabile* is intermediate between these.

All these species are edible.

39. LECCINUM CHALYBAEUM Sing., Mycologia 37:799. 1945.

Pileus between "pinkish buff" and "cinnamon," but more sordid, or more frequently "bamboo" (M. & P.), with a shade of "sphinx" (M. & P.) when young, very frequently with a caesious tinge on the margin or shining through cracks of the surface, often partly "court gray," glabrous or subglabrous-subtomentose, more or less distinctly viscid in wet weather, slightly shining when dry, smooth or slightly uneven, pulvinate, eventually sometimes more applanate, 42-84 mm. broad. — *Hymenophore* whitish, soon "flax" (M. & P.) to "ecru-beige" (M. & P.), convex beneath, deeply depressed around the stipe; tubes up to 14 mm. long; pores concolorous but becoming dirty olive gray when handled, small to very small; spore print olive brown. — *Stipe* white, becoming sordid, beset with white scabrous squamules at the apex, white with pale brown, later darker brown squamules farther downwards, dry, subequal with very slightly attenuate apex, or ventricose, or tapering upwards almost from the base, solid, 40-65 x 13-21 mm. — *Context* white, becoming reddish-violet-gray or purplish lilac ("dark vinaceous gray") when bruised, and eventually becoming blackish, firm and fleshy then watery soft in the pileus and the apex of the stipe, fibrous and hard in the rest of the stipe; odor none; taste mild.

Spores 16.3-17.7 x 5.5-6.2μ, melleous-brownish, well colored, fusoid, the walls thin or somewhat thickened; *basidia* 28-34 x 9.3-13.7μ, 4-spored; *cystidia* 31-51 x 6-11μ, hyaline, fusoid, more often non-ampullaceous than with an ampullaceous apex, thin-walled, rather numerous near the pores; *trama* truly bilateral, of the *Boletus*-type, comparatively thin; *cuticle* of the pileus consisting of strongly interwoven, irregularly arranged (not in erect chains), filamentous brownish or hyaline, smooth hyphae of 4-10μ, usually between 6.5 and 8.5μ diameter; scabrosities of the stipe consisting of strands of parallel hyaline, filamentous hyphae, at the end of each a subhymenial hypha which is shorter and usually broader than the others and bearing, in its turn, either a dermatobasidium (3-4-spored, *e.g.* 20-21 x 9-9.5μ), or a dermatopseudoparaphysis (basidiole-like, small, or irregularly lobed at the apex, mostly hyaline, or very faintly pigmented), or a dermatocystidium (hyaline or much more rarely melleous, fusoid or fusoid-ampullaceous, thin-walled or with a wall of up to 0.7μ diameter, 38-82 x 6.2-16.2μ), these three latter elements forming small fragments of hymenium.

Chemical reactions.—KOH and NH_4OH on pores, deep reddish brown. $FeSO_4$ on context, "pistachio green," "Russian green." — Formol on context, immediately salmon red. — Phenol on context, "dusky brown" or "chocolate."

Habitat.—In gardens, open woods and flatwoods with *Quercus minima,* associated with the latter, or with *Q. virginiana,* or *Q. laurifolia,* on sandy ground or on humus, in small groups or solitary. Fruiting mostly in July.

Distribution.—North Florida, probably also in adjacent states but overlooked and taken for *L. scabrum.*

Material studied.—FLORIDA, ALACHUA Co. Two miles east of Gainesville among *Quercus minima* in a *Pinus-palutris* flatwood during and after strong rains, July 20, 1943, *Singer, F 2846,* TYPE (FH); Gainesville, *Singer, F 2761,* CO-TYPE (FH); *F 2756,* CO-TYPE (FH).

This species differs from *L. duriusculum* in the structure of the cuticle, from *oxydabile* in stronger autoxydation and more equally filamentous-interwoven cuticular hyphae, also in the habitat; from *L. scabrum* and its subspecies in the strongly discoloring flesh and the chemical reactions, also in the mycorrhizal connection; from brown forms of *L. aurantiacum* in the absence of orange pigment in the hyphae of the cuticle and in the caesious or gray stains on the pilei of most specimens, also in the mycorrhizal connection.

Extralimital Species

Leccinum duriusculum (Schulz.) Sing. comb. nov.

Boletus duriusculus Schulz. *apud* Fr., Hymen. Europ. p. 515. 1874.
Gyroporus scaber (Fr. *sensu*) Quélet, Enchir., p. 162. 1886.
Gyroporus griseus Quél., Assoc. fr. avanc. sc. (**1901**):496. 1902.
Boletus griseus Sacc. & D. Sacc., Syll. **17**:100. 1905, *non* Frost (1878).
Boletus rufus var. *duriusculus* Bat., Bolets, p. 12. 1908.
Boletus scaber var. *griseus* Bat., Bolets, p. 12. 1908.
Boletus duriusculus var. *carpini* R. Schulz *in Michael* Führ. Pilzfr. **1**, pl. 95. 1924.
Krombholzia duriuscula Gilbert, Bolets, p. 185. 1931.
Boletus pseudoscaber Kallenbach, Pilze Mitteleur. **1**:117. 1935, *non* Secr. (1833).
Boletus nigrescens Huber, Zeitschr. Pilzk. **19**:75. 1935, *non* Rich. & Roze (1888).
Krombholzella scabra (Bull *ex* Fr. *sensu*) R. Maire, Publ. Inst. Botàn. Barcelona, **3**(4):46. 1937.
Trachypus scaber "Fr., Quél. (*nec* Bull.)" Romagnesi, Rev. de Mycol. **4**:141. 1939.

It is improbable that Schulzer, not to mention those modern French mycologists who maintain *L. duriusculum* as a species different from what we call by this name, made so bad a mistake as to consider the brown form of *L. aurantiacum* as the "actual" *L. duriusculum* without discovering the fact that this form is at most a color form of the typical *L. aurantiacum.* The above list of synonyms shows clearly that in case these authors should have misinterpreted the brown form of *L. aurantiacum* as a "new species," — an assumption so odd it could plausibly be proved only if there are type specimens at Budapest that show the characters of *L. aurantiacum,* — the European species with epithelium, as common and well known as it may be, would remain without a name. The author still thinks, however, that *Boletus duriusculus* Schulzer is the same plant as ours.

The occurrence of this species in North America is not proved, in fact, it is improbable, at least as far as the east coast is concerned, since none of

the specimens seen by the writer belongs here. It occurs in Central and Southern Europe, also in the Caucasus Mts., in North Africa and England.

Leccinum oxydabile (Sing.) Sing. comb. nov.

Krombholzia oxydabilis Sing., Schweiz. Zeitschr. Pilzk. **16**:136. 1938.

This is the frequent species, usually determined as *Boletus scaber*, in the mixed woods of New England and New York, also occurring in Siberia, and probably in Europe (*B. duriusculus sensu* Huber — ?).

LECCINUM AURANTIACUM (Bull *ex*) S. F. Gray, Nat. Arr. Brit. Pl. **1**:646. 1821.

Boletus aurantiacus Bull. *ex* Pers., Mycologia Europ. **2**:147. 1825.
Boletus versipellis Fr. & Hök, Bol., p. 13. 1836.
Krombholzia aurantiaca Gilbert, Bolets, p. 182. 1931.
Krombholziella aurantiaca R. Maire, Publ. Inst. Botàn. Barcelona **3**:46. 1937.
Trachypus aurantiacus Romagnesi, Rev. de Mycol. **4**:141. 1939.
Leccinum versipelle Snell *apud* Slipp & Snell, Lloydia **7**:58. 1944.
Boletus rufus Schaeff. *ex aut. plur.*

This somewhat variable species is most frequent in America and Europe under or near *Populus tremula* and *P. tremuloides*. It is much more rarely found under other trees. Neither the hosts nor the fungus occurs in Florida.

LECCINUM TESTACEO-SCABRUM (Secr.) Sing. comb. nov.

Boletus testaceus scaber Secr., Mycogr. Suisse **3**:8.1833.
Boletus rufescens scaber Secr., Mycogr. Suisse **3**:11. 1833; *B. rufescens* Konrad, Bull. mens. Soc. Linn. Lyon, p. 10. 1932.
Krombholzia rufescens Sing., Rev. de Mycol. **3**:189. 1938.

This is a northern-Alpine species growing with various species of *Betula*, and being especially abundant in the tundras of Europe and Asia. I have seen specimens referable to this species in America. Most European (not French) authors confuse this and *L. aurantiacum* under an ambiguous name like *Boletus rufus* or *Boletus versipellis*.

LECCINUM SCABRUM (Bull. ex Fr.) S. F. Gray. Nat. Arr. Brit. Pl. **1**:647. 1821.

Boletus scaber Bull. *ex* Fr., Syst. Mycol. **1**:393. 1821.
Krombholzia scabra Karst., Rev. Mycol. **3**:17. 1881.
Ceriomyces viscidus (L. *ex*) Murr. North Amer. Fl. **9**:139. 1910, *non Boletus viscidus* L. *ex* Fr. (1838).
Krombholziella scabra R. Maire, Publ. Inst. Botàn. Barcelona **3**:46. 1937.
Trachypus scaber "Bull. *non* Fr.)" Romagnesi, Rev. de Mycol. **4**:141. 1939.

A very common European and American species which has rightly been divided into several subspecies (see Singer, Ann. Mycol. **40**:34. 1942), this has been confused with *L. duriusculum* by many European writers. Nomenclatorially this has also been mixed up unnecessarily. It is obvious for anyone who atempts to apply the International rules impartially that the one issue of importance is what Fries thought was the typical *B. scaber* among

the many forms he initially included. Neither Bulliard's and S. F. Gray's, nor Quélet's and Imler's views count in this regard. Fries has hardly seen much of *L. duriusculum* since he collected only in Sweden where the latter is rare. The last of the varieties indicated in Fries' Systema (1821) is our *L. scabrum*, the form common in Sweden and well known to every mycophagist and farmer there. This species is also most similar to Bulliard's picture, *pl. 132*, as confirmed by the Parisian author H. Romagnesi. As if this were not enough, Fries says generally about *B. scaber* that the *flesh is usually unchanging*, rarely blackening which cannot mean that the blackening species (*L. duriusculum*) is the type form. Since only two of the varieties indicated by Fries do not blacken, *viz. a* and *f*, only these can be considered as candidates for type variety. Both belong in *L. scabrum* in our sense. It is logical that all the other varieties have since been named and have to be excluded from *B. scaber*. The remaining form is our *L. scabrum*. The name *B. leucophaeus* Pers., frequently applied to this species, is incorrect since even the scanty characters given for this species do not fit *L. scabrum* especially the blackening attributed to *B. leucophaeus* by Persoon.

L. scabrum ssp. *niveum* is not infrequent in New England, especially in wet, low woods, with *Betula; L. scabrum* ssp. *rotundifoliae* has recently been found in this Hemisphere, in arctic Canada and Greenland. None of all these occurs in Florida. What is called so there, is either *L. albellum* f. *epiphaeum* or *L. chalybaeum*.

Section **Roseoscabra** Sing. sect. nov.

Hymenophoro haud flavo-tincto, sed base stipitis chromea (haud citrina); sporis in cumulo cinnamomeis vel roseo-fuscidulis; pileo roseo.

Characters of the section: see key and Latin diagnosis. Type species **L. chromapes** (Frost) Sing. comb. nov. (*Boletus chromapes* Fros).

This section is, of the three known sections of this genus, the one closest to *Tylopilus* because of the color of the spores. The type and only species of this section has filamentous cuticle, and the context does not react with methylparamidophenol; it reacts greenish in the "lemon chrome" part of the stipe, not at all in the pileus with formaline, the white part of the flesh becomes "sage green" and "Artemisia green" with $FeSO_4$ while the chrome yellow part becomes slowly more olive. The pileus and the scales of the stipe are about "pinkish vinaceous," the former becomes brownish with KOH and the latter with age. It grows with *Betula, Populus*, and *Salix*, and has not thus far been observed in Florida.

Species Excludendae

LECCINUM LACTIFLUUM (With. *ex* Fr.) S. F. Gray is *Suillus granulatus* (L. *ex* Fr.) Kuntze ssp. *typicus*.

LECCINUM SUBTOMENTOSUM (L. *ex* Fr.) S. F. Gray is *Xerocomus subtomentosus* (L. *ex* Fr.) Quél.

LECCINUM PIPERATUM (Sow., Pers. *ex* Fr.) S. F. Gray is *Suillus piperatus* (Bull. *ex* Fr.) Kuntze.

LECCINUM CONSTRICTUM (Pers. *ex*) S. F. Gray is *Gyroporus cyanescens* (Bull. *ex* Fr.) Quél.
LECCINUM EDULE (Bull. *ex* Fr.) S. F. Gray is *Boletus edulis* Bull. *ex* Fr.
LECCINUM ELEPHANTINUM (With. *ex*) S. F. Gray is a *nomen dubium*.
LECCINUM LURIDUM (Sow. *ex*) S. F. Gray is *Boletus luridus* Schaeff. *ex*. Fr.
LECCINUM RUBEOLARIUM (Sow. *ex*) S. F. Gray is a *Boletus* of the section *Luridi*.

Genera Incertae Sedis

BOLETOCHAETE Sing., Mycologia **36**:358. 1944.

Three tropical species (*B. spinifera* (Pat. & Baker) Sing., the type species, *B. brunneosetosa* Sing., and *B. spec.* = *Xerocomus* sp. Heim), none of them occurring in Florida. This is a characteristic, easily recognizable genus which can, however, not be placed in one of the subfamilies of the Boletaceae as long as the structure of the young hymenophoral trama is unknown (see Singer, *l.c.*)

IXECHINUS Heim, Rev. de Mycologie **4**:20. 1939.

Two species from Madagascar, *I. majus* and *I. minus* Heim. The trama of these species as shown in *fig. 4* by Heim, *l.c.*, may represent a third type of tramal structure among the boletes, characterized by still more gelatinized lateral stratum than is observed in the *Boletus*-type. The *fig. 2* (*l.c.*) shows no clamps but this fact is not conclusive since it is not definitely stated in the text. The exact color of the spores in print and the chemical reactions are unknown. This is certainly a good and very interesting genus. Its final place in the classification of the Boletaceae is difficult to name at present. A special *tribus*, Ixechineae, has been proposed by Heim, for the genus *Ixechinus*.

GASTROBOLETUS Lohwag, Beih. Bot. Centralbl. **42**(2):273. 1926.

This is based on one species, *G. Boedijnii* Lohwag (see also Lohwag *in* Handel-Mazzetti, Symbolae Sinicae **2**:54. 1937) which, in spite of its unique half-angiocarpous character, is in need of a more thorough examination. It would be interesting to know the structure of the trama, the hyphae(whether there are clamp connections at the septa), the color of the spore print, the characters of the cystidia (if there are any), and many other things not mentioned in the diagnoses. It may well be that *Gastroboletus* is close to the gasteromyceteus genus *Truncocolumella*. It has been collected only in northwestern Yunnan, China.

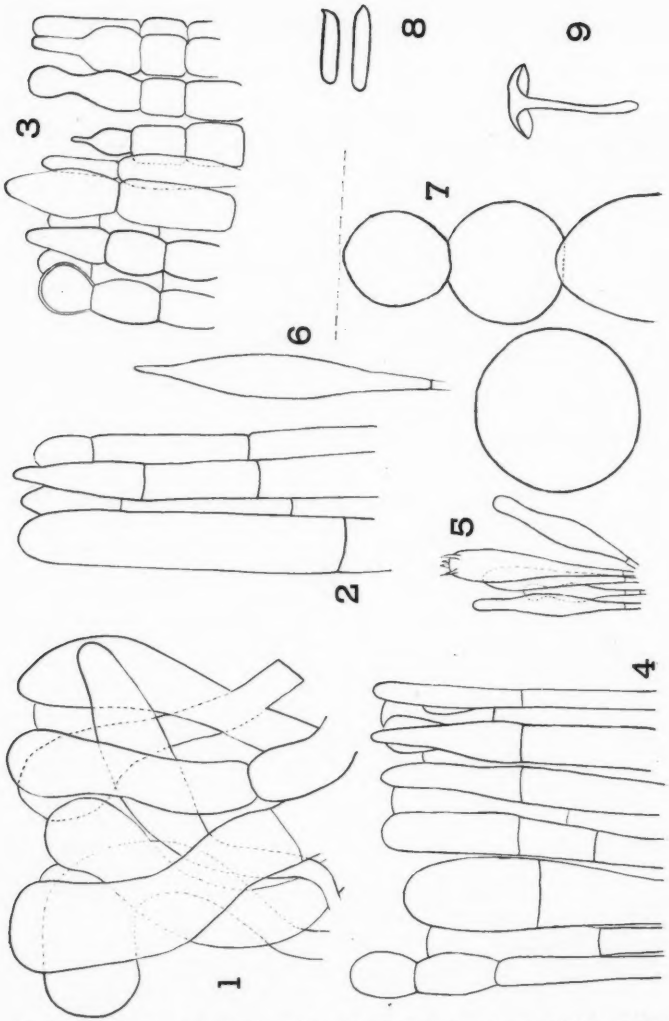

PLATE 1.—*Boletus edulis* Bull. *ex* Fr.—Structure of the epicutis, ×1000.—2. *Boletus aereus* Bull. ex Fr.—Structure of the epicutis, ×1000.—3. *Boletus rubellus* Krombh. ssp. *fraternus* (Peck) Sing. Structure of the epicutis, ×1000.—4. *Boletus granulosiceps* Sing.—Structure of the epicutis, ×1000.—5. *Boletus subsolitarius* Sing.—Fragment of the hymenial layer on the margin of the pileus, ×1000.—6. *Leccinum albellum* (Peck) Sing.—Cystidium of the hymenophore, ×1000.—7. *Leccinum albellum* (Peck) Sing.—Epithelium of the pileus. The broken line above indicate the surface of the pileus, ×1000.—8. *Xanthoconium stramineum* (Murr.) Sing. Spores, ×1000.—9. *Boletus pernanus* Pat. & Baker.—Section through the fresh carpophore in natural size. From a drawing accompanying the type specimens; del. C. F. Baker.

PLATE 2.—*Xanthoconium stramineum* (Murr.) Sing.—Carpophores in various stages of development, fresh material in natural size, from Highlands Hammock State Park, Fla.

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CORRIGENDA

Part I, p. 98, line 28, read: *Suillus cothurnatus* instead of *Suillus australis.*

Part I, p. 100, line 2, read: *Xerocomus pseudoboletinus* instead of *Xerocomus subilludens.*

Part I, p. 104, line 20, read: *Porphyrellus subflavidus* instead of *Porphyrosporus subflavidus.*

Part I, p. 105, line 31, read: *Porphyrellus pseudoscaber* instead of *Porphyrosporus pseudoscaber.*

Part I, p. 111, line 39, read: HNO_3 instead of HNO_4.

Part I, p. 121, line 14, read: *P. Cookei* instead of *P. lacunosus.*

Part II, p. 223, line 3, read: (except *Boletoideae*) instead of (*Gyroporoideae*).

Part II, p. 240, line 32, read: *Gyroporus biporus* instead of *Gyroporus bisporus.*

Part II, p. 243, line 32, read: *Gyrodon lividus* instead of *Gyroporus lividus.*

Part II, p. 247, line 3, read: Linder, det. R. Singer) instead of . . . Linder (det. R. Singer).

Part II, p. 260, lines 11-12, delete: *S. flavoluteus* (Snell) Sing. comb. nov. (*Boletinus flavoluteus* Snell).

Part II, p. 280, line 27, read: Ssp. *foliiporus* (Murr. *l.c.*) Sing. comb. nov. instead of Ssp. *foliiporus* Murr. *l.c.*

Part II, p. 282, line 15, read: *Gymnopilus* instead of *Gymnocybe.*

Part II, p. 292, line 16, read: (FLAS) instead of (FLAS, FH).

Part II, p. 298, line 16, read: altering instead of alternating.

Part IV, p. 539, line 18, delete: (*e.g.* of *Nyssa silvatica*).

Part IV, p. 543, line 33, delete sentence beginning with: We therefore. . .

Part IV, p. 562, line 10, read: Christiansen instead of Lange.

Great Basin Plants—IX. Compositae

Arnica, Hymenopappus, Haplopappus, and Lygodesmia

Bassett Maguire

Arnica

During the preparation of the fuller study of *Arnica* (A Monograph of the Genus *Arnica*, Brittonia 4:386-510. 1943.) I wrote: "It seems impractical, in a comprehensive study of this character, to attempt to work out the limitations of local populations or extensive variants. Evidence of the existence of those populations is plentiful, but no useful purpose could be seen in attempting to do here what can be better accomplished by local field studies, and more appropriately in intensive treatments of local or regional floras." (Op. cit. p. 391).

It seems now desirable to extend the study to this consideration of the more substantial ecologic variants as they can be recognized in the Intermountain area, for reasons of the accumulation of a large amount of recent material not available to the earlier work, and because Professor Holmgren and I are nearing the completion of a sixteen-year field survey of the area preparatory to a detailed treatment of its flora.

Arnica, like so many composite genera, has produced some compact and homogeneous species, and others that are large, loosely defined, and polymorphous. The more compact species, usually of limited geographic range, have few subspecific divergencies or even ecologic variants. On the contrary, and as would be expected, the larger, loosely-knit species of wide distribution, have developed numerous variants, independently, of both geographic and ecologic nature, or some of more or less dual nature. Geographic variants, considered phylogenetically more significant, have been interpreted (Op. cit.) as subspecies. The variants here under consideration are largely of an ecologic nature, and either extend coincidentally with the species, or in some cases tend to have localization in the species or subspecies range. Of the large species, it is only in *A. latifolia* that the pattern is so complex and confused that varietal entities seem inextricable from the maze of morphological interplay. In the several species here treated in which formal recognition of varietal populations is made, the morphologic distinctness of the variants is conditioned by free confluence of character. Hence, any attempted separation by keys achieves the unsatisfactory result of arbitrary metric delimitation of nodally accentuated but none the less continuous characters.

Arnica cordifolia Hook. subsp. genuina Maguire, Madroño 6:154. 1942.

In the more extended treatment (Op. cit. p. 449) I wrote: "*Arnica cordifolia* is essentially a woodland plant, and under this rather constant environment does not display great variability in habit. To be sure, the leaves undergo

some variation in form and size, and the plant produces 1-3 heads, seldom more. In the soft mold and duff of the woods, the rhizomes usually develop extensively, producing numerous shoots and innovations. Generally the leaves are confined to the lower part of the stem, the lowermost with long petioles exceeding the blades, and the uppermost reduced and sessile, but occasionally plants are leafy above. The leaf margins vary, being quite entire or coarsely dentate, and the basal sinus is also variable ranging from broad and open to deep and narrow.

"When the plants occur in transition areas, as along margins of woodlands, or in newly disturbed soil such as roadbanks or dugways, or as the upward altitudinal limit of distribution is approached, divergences in leaf form and pubescence increase; the leaves tend to become smaller, narrower, and to lose their cordate bases, the pubescence becomes denser, harsher, and more glandular, the plants become smaller and frequently more branched and the pappus bristles develop longer setae (0.15-0.2 mm.). It is to these diverse biotypes that the greater number of specific names have been applied."

There are four outstanding assemblages of the character described above that seem to represent definite ecotypes.

KEY TO VARIETIES OF A. CORDIFOLIA SUBSP. GENUINA

1. Plants usually 2-4 dm. tall; leaves cordate, exceeding 5 cm. in length; heads turbinate, periclinium densely pilose.
   2. Leaves less than 10 cm. in length ..... 1. var. *cordifolia*.
   2. Leaves 10 cm. or more in length ..... 2. var. *macrophylla*.
1. Plants usually less than 2 dm. tall; leaves mostly less than 5 cm. in length, cordate, subcordate, truncate, or rounded at the base; heads turbinate or campanulate, periclinium usually sparingly or not at all pilose.
   2. Plants 1-2 dm. high; leaves cordate to rounded at base, 3-5 cm. long, usually pigmented; heads broadly turbinate, periclinium moderately to scantily pilose ..... 3. var. *pumila*.
   2. Plants 0.5-1.5 dm. tall; leaves 2-4 cm. long; heads campanulate; pilosity very sparse or lacking ..... 4. var. *humilis*.

1. var. **cordifolia** Maguire, var. nov.

A. cordifolia Hook. Fl. Bor.-Am. **1**:331. 1834, as to type.

The general population, extending over the entire range, itself variable and polymorphous gives rise to the following three more significant ecologic variants.

2. var. **macrophylla** (Nutt.) Maguire, comb. nov.

A. macrophylla Nutt. Trans. Am. Phil. Soc. II. **7**:407. 1841.

Basal leaves and those of the innovations thin, usually surpassing 6 cm. in width and 10 cm. in length, the margins saliently dentate, and the sinus deep; heads broadly turbinate, the periclinium densely pilose; plants of densely shaded and usually moist habitats; a weak variant, probably distributed throughout the range of the species.

Type locality: "Arnica macrophylla, Blue Mts. of Oregon," Nuttall. Presumably in the Hooker Herbarium, Kew.

Representative specimens: Lodgepole pine woodland, 28 mi. north Ashton, Fremont County, Idaho, June 21, 1939, *Maguire* 17071; lodgepole pine woodland, Buffalo Forest Camp, 35 mi. north Ashton, Fremont County, Idaho, June 22, 1939, *Maguire* 17091; spruce woodland, Middle Fork Park, Wasatch Plateau, 10,500 ft., Sanpete County, Utah, August 10, 1940, *Maguire* 20033.

In similar habitats, specimens of *A. latifolia* (the form represented by the type of *A. grandifolia* Greene) may be habitually comparable to the above, but are to be distinguished from it by the non-reduction in size of the upper cauline leaves, the broader heads, and scant periclinial pubescence.

3. var. PUMILA (Rydb.) Maguire, Madroño 6:154. 1942.

A. parviflora Greene, Pl. Baker. **3**:28. 1901.
A. Evermannii Greene, Ottawa Nat. **23**:215. 1910.
A. abortiva Greene, Leaflets **11**:47. 1910.
A. Austinae Rydb. N. Am. Fl. **34**:340. 1927. Type: Lake City Canyon, California, June 1898, *Mrs. R. M. Austin & Mrs. Bruce* 2165.

Basal and innovation leaves usually less than 5 cm. long and 3 cm. wide, the base cordate with the sinus mostly broad and shallow, or frequently the base truncate, or obtusely rounded; herbage usually pigmented; stems 10-20 cm. high; plants of transition and disturbed areas; throughout the range of the species.

Type locality: Grays Peak, Colorado, 1872, *Torrey*. New York Botanical Garden.

Representative specimens: Mt. Hesperus, 4000 ft., southern Colorado, July 2, 1898, *Baker, Earle, & Tracy* 1001; Big Horn Mountains, Wyoming, 1900, *Tweedy* 3018; dry soil, Everett, 10,200 ft., Lake County, Colorado, July 12, 1910, *Clokey* 3437; moist loam, head Indian Farm Creek, 11,000 ft., Deep Creek Range, July 6, 1943, Juab County, Utah, *Maguire & Holmgren* 21995; under open fir-pine woodland, Copper Mountain, North Humboldt Range, August 7, 1943, Elko County, Nevada, *Maguire & Holmgren* 22355; open *Pinus flexilis* woodland, Lamoille Canyon, 9000 ft., August 19, 1943, Ruby Range, Elko County, Nevada, *Maguire & Holmgren* 22670.

4. var. **humilis** (Rydb.) Maguire, comb. nov.

A. humilis Rydb. N. Am. Fl. **34**:341. 1927.

Plants of reduced stature, 5-15 cm. tall; leaves broadly ovate to subrotund, the base subcordate, or rounded, 2-4 cm. long; 1.5-3 cm. broad; heads campanulate; periclinial pubescence scant, mostly short and harshly glandular; achenes sparingly hirsute, or wholly short stipitate-glandular; a definite alpine ecotype, possibly throughout the range of the species.

Type locality: On "the saddle," Lake Louise, 7000 ft., July 20, 1904, Rocky Mountain Park, Canada, *John Macoun* (Geol. Surv. Canada No. 65504). New York Botanical Garden.

Representative specimens: Utah: Rocky east slopes above Alta, Brighton Pass, 10,200 ft., Wasatch Range, August 7, 1939, Salt Lake County, *Maguire* 17368; same

data. *Maguire* 17369; ridge about snowbank between Alta and Twin Lake, 10,500 ft., Wasatch Range, August 7, 1939, Salt Lake County, *Maguire* 17378; same data *Maguire* 17395; saddle west Mt. Agassiz, Uintah Mountains, Duchesne County, 11,400 ft., August 16, 1933, *Maguire et al.* 4317; slopes east Mt. Agassiz, 13,000 ft., August 18, 1933, *Maguire et al.* 4316; rocky slide, Mt. Hobbs, 10,500 ft., La Sal Mountains, Grand County, July 18, 1933, *Maguire* 26169.

ARNICA CHAMISSONIS Less. subsp. FOLIOSA (Nutt.) Maguire, Rhodora 41:508. 1939.

Except for the wholly circumboreal *A. alpina*, *A. Chamissonis* is the most widespread species in the genus. It is to be expected that considerable diversification would have taken place within the subspecies, particularly within the southern populations.

KEY TO THE VARIETIES OF A. CHAMISSONIS SUBSP. FOLIOSA

1. Involucral bracts moderately to broadly obtuse; herbage pubescence variable; leaves not thin, the margins mostly entire or remotely and minutely denticulate.
   2. Stems less than 7 dm. tall; leaf blades usually less than 15 cm. long and 5 cm. broad.
      3. Involucral bracts obtuse, but hardly broadly rounded and red-margined ..... 1. var. *foliosa*.
      3. Involucral bracts very broad and rounded, usually red-margined ..... 2. var. *bernardina*.
   2. Stems 7-10 dm. tall, leaf blades 12-20 cm. long and 4-7 cm. broad ..... 3. var. *Maguirei*.
1. Involucral bracts acutish; herbage minutely puberulent; leaf blades thin, the margins remotely but sharply denticulate ..... 4. var. *Jepsoniana*.

1. var. **foliosa** Maguire, var. nov.

A. foliosa Nutt. Trans. Am. Phil. Soc. II. 7:407. 1841, as to type.

An extremely polymorphous population readily responding to environment, from which the following designated varieties seem to be ecotypically distinct.

Type locality: "On the alluvial flats of the Colorado of the west, particularly near Bear River, of the Lake Timpanogos" [Great Salt Lake]. Presumably in the Nuttall collection at the British Museum.

Representative specimens: Beatty's Butte, Oregon, altitude 1830 m., July 23, 1896, *Leiberg* 2608; dry meadows, Alturas Lake, Blaine County, Idaho, August 11, 1916, *Macbride & Payson* 3730; open meadow, Stanley Lake, Sawtooth Mountains, Idaho, 6500 ft., July 25, 1937, *Thompson* 13960; Henry's Forks, Snake River, Fremont County, Idaho, July 9, 1939, *Cronquist* 1565; Buffalo River, Government Bridge (Yellowstone National Park), Wyoming, August 5, 1901, *Merrill & Wilcox* 1092; Breckenridge, Summit County, Colorado, 9700 ft., August 1901, *Mackenzie* 214; meadows, Grizzly Creek, Larimer County, Colorado, August 12, 1903, *Gooding* 1863; Fish Lake, Sevier County, Utah, August 10, 1905, *Rydberg & Carlton* 7550; dry meadow, Stillwater Fork, Uinta Mountains, Summit County, Utah, *E. B. & L. B. Payson* 4973; moist creek bottom meadow, San Juan Creek, Toiyabe Range, Nye County, Nevada, August 9, 1939, *Train* 3315; drier meadows, Terrace Ranger Station, Lamoille Canyon, 8500 ft., Ruby Range, Elko County, Nevada, August 18, 1943, *Maguire & Holmgren* 22627.

2. var. BERNARDINA (Greene) Jepson, Man. Fl. Pl. Cal. 1157. 1925.

Involucral bracts exceedingly broad and blunt, this character passing freely into the less broad condition of other populations of the species; herbage variously pubescent, but more often conspicuously villous; apparently localized in the San Bernardino Mountains, California, and vicinity.

Type locality: San Bernardino Mountains, California, *S. B. & W. F. Parish* 1448. Notre Dame.

Representative specimens: Cienega near Bluff Lake, San Bernardino County, California, August 3, 1902, *Abrams* 2880; meadows, Bluff Lake, San Bernardino Mountains, California, 7400 ft., *Goodman & Hitchcock* 1780; moist meadow, Bluff Lake, San Bernardino Mountains, California, July 9, 1931, *Clokey* 5312.

The most prevalent form in the San Bernardino Mountains, but there passing freely into the var. *foliosa*. Occasionally specimens from outlying areas are intermediate in bract character to var. *bernardina*, as in two recent collections, viz., meadow, head Crooked Creek, 11,500 ft., White Mountains, Inyo County, California, *Maguire & Holmgren* 26057, 26149.

3. var. MAGUIREI (A. Nels.) Maguire, Rhodora 41:508. 1939.

Stems 7-10 dm. tall; leaves 7-10 pairs, the blades 12-20 cm. long, 4-7 cm. broad; plants of moist, protected, and partially shaded places; localized about north (outlet) end of Lower St. Mary Lake, Glacier Park.

Type locality: Low grassy open willow and cottonwood woodland, north of outlet Lower St. Mary Lake, 4460 ft., Glacier National Park, Montana, August 4, 1932, *Maguire* 1098. Rocky Mountain Herbarium. A collection of the same data, *Maguire* 15356.

The population of var. *Maguirei* at the type station possibly represents an extensively developed clone; however, there are numerous and completely intergrading specimens in the area connecting these giant plants with those of more normal size.

4. var. **Jepsoniana** Maguire, var. nov.

A. foliosa var. *Sonnei* (Greene) Jepson, Man. Fl. Pl. Cal. 1157, in part as to specimens, not as to name, 1925; not A. Sonnei Greene.

Rhizomatibus gracilibus nudis; caulibus simplicibus, 4-6 dm. altis; foliis 4-5 jugis, lanceolatis, petiolatis, apices versus diminuendis; capitulis 10-12 mm. altis, bracteis aliquantum acutis.

Stems slender, 4-6 dm. tall; cauline leaves 4-5 pairs, blades lanceolate, with both base and apex acute, remotely but sharply serrate, thin, sparingly puberulent, the lowermost leaves with petiole equaling the blade, leaves diminishing upwards; heads 10-12 mm. high; involucral bracts acutish.

Known only from the west slopes of the Sierra Nevada west of Reno, Nevada, and from the White Mountains in Esmeralda County, Nevada.

Type locality: In scattered dense patches in damp soil, on sheltered meadowland, near streams, Chiatovitch Creek, White Mountains, Esmeralda Coun-

ty, Nevada, altitude 2440 m., July 6, 1931, *Duran* 3100. New York Botanical Garden.

Representative specimens: Truckee, California, July 1894, *Sonne* sine no.; Little Valley, Washoe County, Nevada, 2000-2155 m., July 24, 1902, *Baker* 1354.

The var. *Jepsoniana* is the most discrete variant in the ssp. *foliosa,* set off by the distinctive, thin, sharply serrate and petiolate lower cauline leaves, which diminsh upwards on the stem. With regard to leaf petiolation, it seems to be the homologue of the var. *scaberrima* in *A. mollis,* and of the ssp *prima* in *A. amplexicaulis.* Interesting parallel development is thus seen in three of the major species of the subgenus *Chamissonis.*

ARNICA MOLLIS Hook. Fl. Bor.-Am. 1:331. 1834.

In the west coast states there is a very strong tendency for *A. mollis* to develop petiolate lower cauline leaves. Earlier attempts were made to interpret them as subspecifically distinct from eastern populations. This disposition was not tenable, since about one-third of the western plants have sessile leaves and are inseparable from the Rocky Mountain complex. No major subspecific entities seem to occur in the otherwise variable and polymorphic species.

KEY TO THE VARIETIES OF A. MOLLIS

1. Leaves lanceolate to oblanceolate, weakly serrate; periclinium usually long stipitate-glandular.
   2. Cauline leaves usually in 3 pairs, the lowermost usually not petiolate; periclinial pubescence not harsh ..... 1. var. *mollis.*
   2. Cauline leaves usually in 4 pairs, the lowermost usually petiolate; periclinial pubescence harsh ..... 2. var. *scaberrima.*
1. Leaves broadly lanceolate to ovate, thin, strongly and coarsely serrate; periclinium usually without long stipitate-glandular hairs ..... 3. var. *silvatica*

1. var. **mollis** Maguire, var. nov.

A. mollis Hook. Fl. Bor.-Am. 1:331. 1834, as to type.

Representing the polymorphous population of extensive Rocky Mountain, Intermountain, and Cascade-Sierra Nevadan distribution, apart from the following ecologic segregates.

Type locality: *"Drummond,* alpine rivulets of the Rocky Mountains" [probably Alberta]. Kew.

2. var. SCABERRIMA (Greene) Smiley, Univ. Cal. Pub. Bot. 9:386. 1921.

A. Merriami Greene, Pittonia 4:36. 1899.
A. rivularis Greene, Pittonia 4:163. 1900.

Usually robust plants mostly with 4 pairs of cauline leaves, the lower pair oblanceolate and usually petiolate; pubescence harsh, that of the periclinium sometimes non-stipitate; chiefly confined to the western part of the species range; in the Cascade and Sierra Nevada Ranges.

Type locality: Moist places, Little Kern River, 9000-10,000 ft., California, 1897, *Purpus* 5260. U. S. National Herbarium No. 328648.

Representative specimens: Lake Tahoe, California, 7760 ft., August 9, 1909, *McGregor* 62; Halfmoon Lake, 2500 m. altitude, July 28, 1910, Eldorado County, California, *Hall* 8817; Mt. Paddo, Oregon, 2000 m., July 1908, *Suksdorf* sine no.

3. var. **silvatica** (Greene) Maguire, comb. nov.

A. silvatica Greene, Pl. Baker. 3:27. 1901.

Cauline leaves 3-4 pairs, broad, coarsely toothed, thin, heads usually a little smaller than in var. *mollis*, and usually devoid of long stipitate glands; plants of moist places or open woodlands; known only the Rocky Mountains from British Columbia to Colorado and Utah.

Type locality: Ruby, Colorado, August 7, 1901, *Baker* 715. Notre Dame.

Representative specimens: Rattlesnake Falls, Missoula, Montana, July 18, 1925, *Kirkwood* 2103; Bridger Peak, Carbon County, Wyoming, August 22, 1903, *Gooding* 1950; moist rocky hillsides, Fish Creek Falls, Routt County, Colorado, July 21, 1903, *Gooding* 1635; cold damp soil, Loch Vale, Estes Park, Larimer County, Colorado, altitude 3125 m., September 16, 1920, *Clokey* 3961; open grassy place along stream, trail to Burro Pass, 9000 ft., La Sal Mountains, Grand County, Utah, *Maguire* 26166.

ARNICA DIVERSIFOLIA Greene, Pittonia 4:171. 1900.

This species has previously been known from Alaska, British Columbia, and Alberta south to northern California and northern Montana. Now by considerable disjunct the range is extended to the Bear River Range in Cache County, Utah, and adjacent Idaho. For the most part, the Bear River Range specimens are entirely representative of the variable northern and western population, with the exception of two collections (*Snell* 1014 and *Maguire* 16102) that differ somewhat in habit and in having entire rather than serrate-dentate leaf margins. Another collection (*Maguire* 17419) from the Wasatch Range in Salt Lake County is tentatively assigned to *A. diversifolia*, but seems to approach *A. mollis* in general form. Neither of these biotypes warrants formal characterization.

The following collections establish this new and considerable range extension record: Bear River Range, Cache County, Utah: Under spruce, saddle north Mt. Naomi, 9500 ft., July 20, 1936, *Maguire & Hobson* 14192; under spruce, Tony Grove Lake, 8500 ft., August 18, 1938, *Maguire* 16139; northwest Tony Grove Lake, *Snell* sine no., under spruce 2 mi. northwest Tony Grove Lake, 8600 ft., August 18, 1938, *Maguire* 16141; north slopes, White Pine Lake, 8600 ft., *Snell* 1014; moist places, Tony Grove Lake, August 17, 1938, *Maguire* 16102. Wasatch Range, Salt Lake County, Utah: talus slopes, Lake Catherine, 10,000 ft., 3 mi. south Brighton, August 7, 1939, *Maguire* 17419.

ARNICA sp.

In 1937 Dr. R. J. Davis collected an extraordinary *Arnica* (Bungalow, Clearwater County, Idaho, June 22, 1937, *Davis* 281) that I am so far unable to interpret. The specimens consist of two separate stems, possibly from the same plant, but lack any portion of the rootstock. The two stems are 7.5 and

9 dm. tall respectively, each bearing 6 pairs of very large, thin, sessile leaves, and on the more vigorous a well-developed inflorescence with 13 heads. The affinities of this plant seem to lie with *A. amplexicaulis*. More complete collection and field observations are essential before it can be demonstrated to be an established natural population, or whether it represents a possible isolated hybrid of uncertain origin.

HYMENOPAPPUS

Hymenopappus nudipes Maguire, sp. nov.

Plantae perennes, multicipitales, scaposae; caulibus 10-25 cm. altis, gracilibus, glabratis vel tomentosis; foliis basilaribus, bipinnatis, 5-10 cm. longis, lobulis pergracilibus, obtusis; inflorescentibus paucicapitulatis; capitulis turbinato-campanulatis vel campanulatis; flosculis flavis 12-18, bractiis 8-10, late oblongis, obtusis, tomentulosis; vaginis foliosis marcescentibus, glabratis; acheniis 4-6 mm. longis, costis dense villosis, intercostis rarite villosis vel glabratis.

Multicipital perennial, scapose; stems 10-25 cm. tall, slender, essentially glabrous, or tomentose and tending to become glabrate; leaves bipinnate, 5-10 cm. long, the rachis and petioles narrowly winged, the pinnules linear, usually 5-8 mm. long, blunt, essentially glabrous or densely white-tomentose and becoming glabrate, leaf base sheathing, densely tomentose in the axils, old sheaths marcescent, castaneous, glabrate; involucral bracts 8-10, broadly oblong, obtuse, 5-8 mm. long, thinly tomentose, bearing subglabrate, broadly scarious, sometimes erose margins; florets 12-16 (18), goblet-shaped, the tube glandular, the throat glabrous, short-campanulate, the lobes triangular-ovate, reflexed, $^1/_3$-$^1/_4$ the length of throat; achenes (4) 5-6 mm. long, densely villous on the 4 principal costae, glabrous or slightly villous in the internerves; squamellae more or less the length of tube, broadly oblong, obtuse or acute, scarious, erose, midrib conspicuous.

Type locality: Frequent, under yellow pine and manzanita, sandy soil, 5800 ft., 15 mi. north of Orderville, Kane County, Utah, June 15, 1940, *Maguire* 18740. New York Botanical Garden.

I agree with Johnston (Contrib. Gray Herb. n. s. 68:97. 1923.) that *H. lugens* is restricted to southern California and Lower California. *H. nudipes* is obviously most closely related to *H. lugens*, but our species differs consistently in less finely divided leaves, less dense tomentum, and usually conspicuously shorter throat of the florets. *H. nudipes* is closely related to *H. parvulus* Greene, known only by the type *C. F. Baker* 840, from Gunnison, Colorado, that consists of a series of low scapose plants with small corymbosely arranged heads, representing a single biotype.

Hymenopappus nudipes, habitually characterized by reduced stature, basally disposed bipinnate leaves, glabrescent marcescent leaf-sheaths, and few number of florets, is known only from poor gravelly soil under yellow pine, or from partially denuded slopes in Iron and Kane Counties, Utah. Two apparently distinct ecotypes have been differentiated, one more slender, less pubescent, and with slightly fewer florets at lower altitudes, and a lower-growing, more pubes-

cent plant with a few more florets per head at upper altitudes, notably at Cedar Breaks.

1. var. **nudipes** Maguire, var. nov.

Caulibus 15-30 cm. altis, foliis caulinis glabratis; flosculis 12-15; acheniis intercostis glabratis.

Stems 15-25 (30) cm. tall, slender, glabrate; leaves green, thinly tomentulose or glabrate; heads turbinate-hemispheric, florets 12-15, achenes glabrous or sparingly villous between the costae.

Type locality: *Maguire* 18740, loc. cit.

Representative specimens: Frequent, bare gravelly sand slopes under yellow pine, 5.5 mi. west Divide, 27 mi. south Panguitch, Kane County, Utah, July 17, 1940, *Maguire* 19652; frequent, dry stony slopes under yellow pine, headwaters, East Fork, Virgin River, 15 mi. northwest Orderville, Kane County, Utah, June 19, 1940, *Maguire* 18867; frequent, talus below Pink Cliffs, headwaters East Fork, Virgin River, 15 mi. northwest Orderville, Kane County, Utah, June 17, 1940, *Maguire* 18806.

2. var. **alpestris** Maguire, var. nov.

Caulibus 10-20 cm. altis; foliis caulinis tomentosis; acheniis intercostis sparse villosis.

Stems 10-20 cm. tall, tomentose; leaves tomentose, becoming glabrate; heads hemispheric, florets 14-16 (18); achenes sparsely villous between the costae.

Type locality: Common, Cedar Breaks Rim, 10,400 ft., Iron County, Utah, June 23, 1940, *Maguire* 19023. New York Botanical Garden.

Representative specimens: Frequent, loose calcareous sandy-clay rim, Cedar Breaks, 10,500 ft., ½ mi. east Museum, Iron County, Utah, July 12, 1940, *Maguire* 19467; Cedar Breaks, June 22, 1942, *Degner* 16498; clay banks, Cedar Breaks, *Goodman & Hitchcock* 1593, intermediate to var. *nudipes;* northwest rim, Bryce Canyon, Garfield County, Utah, June 29, 1942, *Degner & Peiler* 16512, intermediate to var. *nudipes.*

HAPLOPAPPUS

Haplopappus Nuttallii Torr. & Gray, var. **depressus** Maguire, var. nov. Minor variation no. 3, Hall, Carnegie Inst. Wash. Publ. 389, p. 69, 70, 1928.

Plantae dense depresso-caespitosae, 3-6 (10) cm. altae; foliis 1.0-1.5 (2.0) cm. longis, 2-4 (5) mm. latis, valde denticulato-serratis, dentibus parvulis valde albo-aristatis; pedunculis subnudis, 1.5-2.5 cm. longis, unicapitulis.

Type locality: Frequent; with *Arenaria Kingii, Sphaeralcea caespitosa,* and *Eriogonum Shockleyi,* shallow gravelly and sandy soil, Warm Point, 5 mi. southwest Desert Range Experiment Station Headquarters, Millard County, Utah, June 18, 1941, *Maguire* 20859. New York Botanical Garden.

Representative specimens: Frequent, *Pinus monphylla - Cercocarpus arizonicus* assn., stony, sandy, limestone soil, 38 mi. west Milford, Beaver County, Utah, June 22, 1941,

Maguire 20984; Lone Mountain, Eureka County, Nevada, June 12, 1944, *Ripley & Barneby* 6223; Major's, White Pine County, Nevada, June 17, 1944, *Ripley & Barneby* 6311a; bare clay ridges, Needle Mountains, east of Peck Station, Lincoln County, Nevada, May 27, 1945, *Ripley & Barneby* 6417.

The var. *depressus* is distinguished from the var. **Nuttallii,** var. nov. (*H. Nuttallii* T. & G. N. Am. 2:242. 1842, as to type.) by its low densely caespitose habit, the relatively long naked peduncles extending beyond the leafy portion of the short stems, and the conspicuous long white bristles along the leaf margins.

Apparently the var. *depressus* is mostly centered in stony, sterile soils in west desert regions of central eastern Nevada and central western Utah. From Hall's description (Op. loc.) the specimens from Deep Creek [western Juab County], Utah, June 6, 1891, *Jones,* University of California, certainly are to be referred to var. *depressus*. Examination of the several collections now available fails to show stigma difference in this variety as contrasted with the character in var. *Nuttallii*. Apparently the distinction Hall found in the Jones collection cited above (appendages shorter than stigamtic portion, as against the appendages being longer than the stigmatic portion) is not constant for the dwarfed population.

Intergradation with var. *Nuttallii* is probably frequent. *Maguire* 20875 from Warm Point Ridge, only a few miles from the type locality, is an example, as is the collection of *Kearney & Peebles* 13632 from House Rock Canyon, Coconino County, Arizona.

LYGODESMIA

Lygodesmia grandiflora (Nutt.) Torr. & Gray, var. **stricta** Maguire, var. nov.

Caulibus gracilibus simplicibus, 1.5-3.0 dm. altis; foliis tenuis strictis.

Type locality: Frequent, on adobe clay, 1 mi. south of Price, Carbon County, Utah, June 5, 1940, *Maguire* 18417. New York Botanical Garden.

Representative specimens: Carbon County, Utah: Sage parks, West Tavaputs Plateau, 20 mi. north of Wellington, June 9, 1940, *Maguire* 19593; on rocky slopes 1/8 mi. west Royal, June 5, 1940, *Maguire* 18412, intermediate to the typical population.

The var. stricta is a habitat variant distinguished from the polymorphous var. **grandiflora** Maguire, var. nov. (*Erythremia grandiflora* Nutt. Trans. Am. Phil. Soc. n. s. 7:445. 1841, as to type; *Lygodesmia grandiflora* (Nutt.) T. & G. Fl. N. Am. 2:485. 1843.) altogether by the unbranched slender stems and strictly ascending narrow leaves. The population seems to be localized in Carbon County, Utah, but numerous intermediate plants are found in herbaria.

Introgression in Sugar Maples—II.*

Pierre Dansereau and Yves Desmarais

In a study of leaf variation in *Acer saccharophorum* K. Koch and *Acer nigrum* Michx. f. from colonies in Massachusetts, Michigan, Illinois and Missouri, Anderson and Hubricht (4) infer that even when these two maples grow intermingled and flower at the same time, there are no intermediate individuals. Consequently there would be no hybridization. A subsequent study in the Laurentian range of *Acer saccharophorum* by Dansereau and Lafond (11) points out that at least in this region, there is not only hybridization, but also introgression.

Wherever two species likely to hybridize grow together, and conditions are more favorable to one than to the other, introgressive hybridization may occur. Anderson and Woodson (5) have described this phenomenon as a contamination of the germplasm of one species by the germplasm of the other. The species less favored by present conditions will gradually be absorbed by the other, and the external characteristics of the hybrids will be more and more those of the best pre-adapted species. Such seems to be the case for the laurentian maples. According to Dansereau (10) the climate of southern Quebec is growing colder; the few stands where *Acer nigrum* can still be found would be relics of a xerothermic period. Now, this latter species is apparently in disadvantageous conditions in a colder and moister climate. If *Acer saccharophorum* and *Acer nigrum* can interbreed freely, we may expect introgression of the characters of the latter by those of *Acer saccharophorum*. That is what Dansereau and Lafond (11) have attempted to show: a) they have found a great number of intermediates between *Acer saccharophorum* and *Acer nigrum;* b) the recombination is in favor of *A. saccharophorum* and to the detriment of *A. nigrum*.

Subsequent measurements on leaves of many other laurentian populations confirm this tendency. Identical measurements made on maple leaves from Illinois, where *Acer nigrum* grows in seemingly more favorable climatic conditions, show an increase of this tendency: one is even tempted to argue that introgression takes place in the opposite direction, to the benefit of *Acer nigrum*. Finally, measurements on herbarium specimens support this hypothesis.

Method

We have used the same method as Dansereau and Lafond (11) in their previous study on maple leaves. This method has the advantage of pure biometry, while taking into account some factors which can not be expressed directly in numbers. Devised by Anderson (1), it has been subsequently used by many authors in studies of various genera; in *Iris* by Riley (17), in *Tradescantia* by Anderson and Hubricht (3), in *Solidago* by Goodwin (12), in

* Contribution from the *Service de Biogéographie, Université de Montréal.*

Baptisia by Larisey (13), in *Aster* by Wetmore and Delisle (19), in *Cistus* by Dansereau (9).

First, a selection of the typical characteristics of each species is made and represented by letters. Thus, the characters of *Acer saccharophorum* will be represented by the letter S and those of *Acer nigrum* by the letter N. Intermediate characters will be represented by the letter I. If five series of characters are studied on each plant, pure *Acer saccharophorum* individuals will have the formula SSSSS and pure *A. nigrum*, NNNNN. The intermediates, if they are present, can have formulae representing all possible combinations of these characters, such as IIIII, SSIIN, SSSNN, etc.

In order, however, to plot these values on a graph or diagram, the letters can be translated into figures. Thus, the characters represented by the symbol S will have the value 0, I will be equal to 1, and N equal to 2. The total value of the different individuals will vary from 0 for the pure *A. saccharophorum* (SSSSS) to 10 for the pure *A. nigrum* (NNNNN). The total index values of all the individuals of a colony will be expressed on a diagram in order to compare various populations. The pure colonies have all their members at one end or the other of the scale. If there is hybridization in stands where two species grow together, the plants will have different values between 0 and 10. If hybridization favors one parent or the other, most of the individuals will have values towards one end or the other of the diagram; the diagrams will then indicate the relative degree of introgression, as well as the relative homogeneity of the population.

Sampling

The specimens have always been collected in homogeneous woods, inside quadrats determined after Braun-Blanquet's method (6). In each quadrat, twigs were chosen at random, from healthy branches, without fructification, not less than five feet in height. On each twig, we have chosen the most normal leaf. Each quadrat has been studied separately,[1] and for each one we have made a diagram showing the frequency distribution (figs. 4, 5, 6).

In addition to the study of leaves collected in maple groves, we have made the same measurements on herbarium specimens from several regions. These last measurements do not have the same value as the former, but they are interesting, because they ratify the data obtained by the first method (fig. 8).

Characters Studied

The whole taxonomic question as to whether *A. saccharophorum* and *A. nigrum* are valid species or mere varietal segregates, and the further question as to whether the varieties *Schneckii* and *Rugelii* are legitimate entities and of what hierarchical status, centers about pubescence and leaf outline. Some

1 Complete phytosociological data are available, including abundance and sociability of all species. A mesophily index for each quadrat could eventually be established to characterize the effect of present environmental conditions in each one.

authors stress the one, and some the others.[2] In the hope that the present study can be of some value towards a dynamic approach to such a problem, we found it advisable to give a maximum of 6 points to leaf outline as well as to pubescence.

The aim of this work was to measure the extent of hybridization between *A. saccharophorum* and *A. nigrum*, if it was taking place, by means of leaf characters. Following Anderson and Hubricht (4) we have studied pubescence on three different parts of the leaf: the primary vein, the lower surface, and the petiole (See table 1, reproduced from Dansereau et Lafond [11]).

TABLE 1.—Series of characters covering the variations of *Acer saccharophorum* and *A. nigrum*.

Series I. Axils of primary veins on lower surface of leaf.

A = 0 Glabrous or essentially so. (Fig. 1A).
B = 1 Visible through pubescence. (Fig. 1B).
C = 2 Not visible through pubescence. (Fig. 1C).

Series II. General lower surface of leaf.

D = 0 Glabrous or essentially so. (Fig. 1A).
E = 1 Covered with scattered hairs, not interlacing. (Fig. 1B).
F = 2 Covered with interlacing hairs. (Fig. 1C).

Series III. Petiole.

G = 0 Glabrous or essentially so. (Fig. 1A).
H = 1 Pubescent only at junction with leaf. (Fig. 1B).
I = 2 Pubescent entire length. (Fig. 1C).

Series IV. Number of lobes. (Fig. 3).

J = 0 15 to 20 lobes.
K = 1 11 to 14 lobes.
L = 2 7 to 10 lobes.
M = 4 3 to 6 lobes.

Series V. Sinus of lower lobes. (Fig. 3).

N = 0 Very deep (about 60°).
O = 1 Open (60° to 120°).
P = 2 Very open or none (120° to 180°).

2 Here are some identifications in the Herbarium of the University of Illinois and in that of the New England Botanical Club. Rehder labels *A. saccharum* specimens corresponding to the following formulae of our table 1: CEIKO; *A. saccharum* var. *Schneckii* our CEIKN; Trelease labels *A. saccharum* our AEGJP, CEHKO, BFGJN, ADGLN, BEGNP, ADGLO; *A. nigrum* our BDGMO, BFGMP, BFGMO, BEGKN, BEGMO, BFGLP; *A. saccharum* var. *Rugelii* our BEHLP, CFHMP, BEGMO, BFHMP, ADHMO.

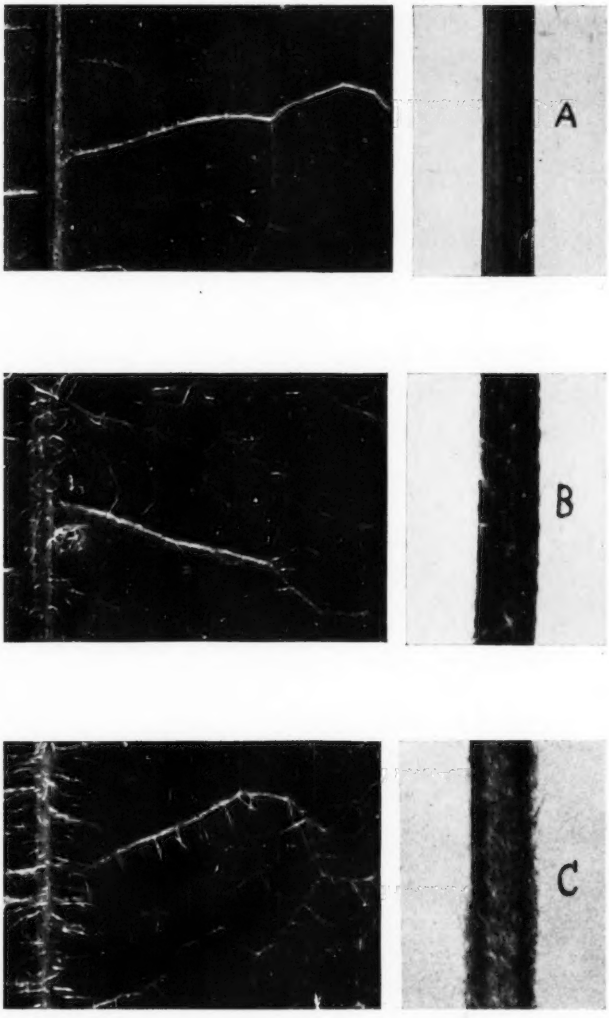

Fig. 1. A. Glabrous leaf, primary vein and petiole (ADG). B. Slightly pubescent leaf, primary vein and petiole (BEH). C. Pubescent leaf, primary vein and petiole (CFI). Photo Lucien Lévesque, C.S.C.

Figure 1 shows what is meant by the different degrees of pubescence. Intermediate values (= 1) for pubescence on primary veins or general lower surface of the leaf were given for those individuals in which hairs were not dense enough to touch each other had they made a complete turn.

There was some difficulty about the pubescence of the petiole at the junction with the leaf. Many individuals had hair tufts at the junctions of primary and secondary veins (fig. 2) The value 1 has been given only when the petiole itself was covered with hairs (fig. 1B).

Anderson and Hubricht (4) have studied the outline of the leaf by means

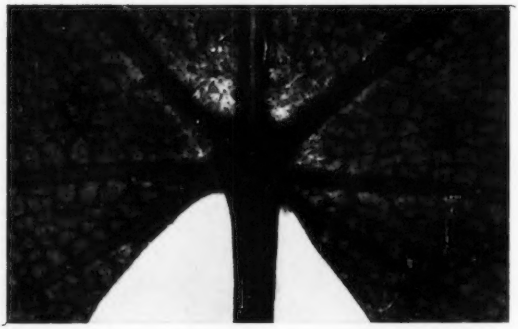

Fig. 2. Leaf with tufted hairs at the junction of primary veins (G). Photo Lucien Lévesque, c.s.c.

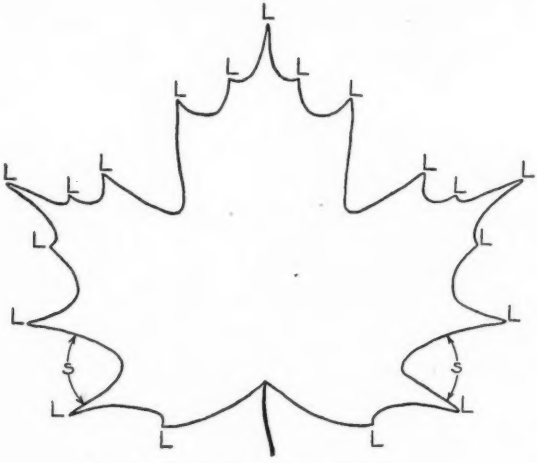

Fig. 3. L, lobes, S, sinus of lower lobes.

of a graphical method. The series IV and V were those used by Dansereau and Lafond (11) in the same intent. The number of lobes of sugar maple leaves from the Gaspé Peninsula, one of the most distant spots from any black maples, where possibility of hybridization is remotest, was between 15 and 20. We have given the value 0 to all specimens with such a number. By lobes we do not mean only the parts of the leaf divided by deep sinuses, but also the lobules on the outline of the leaf, as illustrated in fig. 3. In giving a value of 4 to individuals with 3 to 6 lobes (M) and of 0 to those with 15 to 20 (J), only theoretical extremes have been considered. It can be argued that J is frequent and that occasional individuals are found with even more than 20 lobes, whereas M is rare, at least amongst available specimens, even in the southwestern *saccharophorum*-less area. But frequency, normal occurrence and such criteria can hardly be applied when the very object of the study is to discover percentage of incidence of all characters. If an exact equivalence were to be maintained between J, K, L and M, each should contain only 4 alternatives as is the case for K, L and M, whereas J contains 6. Actually, these figures can hardly be taken literally. What is meant by J is a strongly lobulate leaf, in contrast to M where more or less early abortion of the lobules (usually with vestiges) has taken place. At all events, an extra category might conceivably have displaced a few specimens towards the right in some of the graphs, but would hardly have modified the genetic or geographical tendencies implied. It is not the purpose of this paper to propose absolute values of any kind but to emphasize relative positions and probable shifts.

Series V is based on the more or less open angle of the lower sinus. This angle often represents the tendency for *A. saccharophorum* leaves to be more dissected and for those of *A. nigrum* to have a more entire outline, following the abortion or resorption of the two lower lobes. There are many variations of that pattern. Some leaves with very few lobes have long tapering lobules. Marie-Victorin and Rousseau (16) have described such a form as forma *angustilobatum*. Other specimens of the same type occur in Illinois, Missouri, etc.

Anderson (2) has shown that in recombinations all the expected genotypes were not realized, even when observations were extended to a great number of individuals. Such limitations would be induced by both genetical and ecological factors. In a study on *Cistus*, Dansereau (8, 9) had found only 151 different character combinations out of 324 possible in *Cistus salviifolius*, and 77 out of 144 for *Cistus monspeliensis*. Dansereau and Lafond (11) with 240 maple leaves, have found only 28 different combinations out of 324 theoretically possible. With the present measurements, made on 1140 leaves, we have found 79 of the 324 possible phenotypes.

Observations

Table 2 and the diagrams of figure 4 represent the measurements made on maple leaves from typical *Acer saccharophorum* colonies. The introgression index of all these colonies is very low. The weak pubescence and the less dis-

TABLE 2.—Pure colonies of *Acer saccharophorum*, showing the distribution of individuals per index-value category according to the formula of table 1. See also fig. 4.

Index value	A Mt St-Pierre, Que.	B Mt Johnson, I, Que.	C Beauceville, Que.	D St-Elzéar, Que.	E Mt Johnson, II, Que.	F Bon Conseil, Que.	G Cleveland, Ohio	H Guénette, Que.	I St-Sébastien Que.	J Marbleton, Que.	K Jericho, Vt.
0	2 ADGJN	3 ADGJN	5 ADGJN	5 ADGJN		28 ADGJN	6 ADGJN	4 ADGJN	5 ADGJN	13 ADGJN	2 ADGJN
1	8 ADHJN	16 ADHJN	20 ADHJN	23 ADHJN	19 ADHJN	7 ADGJO 2 ADHJN 1 ADGKN	3 ADGJO	1 ADGJO	3 ADGKN 3 ADGJO	2 ADGKN 4 ADGJO	2 ADGKN
2			1 AEHJN	5 AEHJN		1 BDHJN 3 ADGKO	1 ADGKO	1 BDGKN 1 AFGKO	8 ADGKO	23 ADGKO	8 ADGKO
3											
4					1 ADHLO						

sected outline of a few leaves can be interpreted as the remains of an ancient hybridization, followed by an almost complete absorption by *A. saccharophorum;* or as the vestiges of the characters of a common ancestor of this maple and *A. nigrum,* as suggested by Cain (7).

In the six following colonies (table 3 and fig. 5, A to F) some individuals depart from the *saccharophorum* pattern because of a reduced number of lobes or a less dissected outline.

The leaves of the colonies of table 4 and fig. 5 G to N, in contrast to the preceding, depart from the *saccharophorum* type chiefly because of a more or less dense pubescence.

The last seven colonies are located on the northern limits of the area of *Acer saccharophorum.* If pubescence is a remains of hybridization with *Acer nigrum,* it should be in this region that we ought to find the most glabrous specimens, as they are located more than 150 miles north of the last known individuals of *A. nigrum.* It would have been less amazing to find such pubescence on maples from Quebec's Eastern Townships (fig. 5 A to D) which are located nearer *A. nigrum.* However, Marie-Victorin and Rolland-Germain (15) looked at pubescence in northern maples as a defense mechanism of the plant against cold, as the pubescence of *Acer nigrum* would be a protection against too intense evaporation in the Southwest. These authors described a northern variety of maple, *A. saccharophorum* var. *subvestitum,* pubescent on the lower surface of the leaf and on the twigs.

This pubescence may be a persistence of a *nigrum* character in this region placed under the influence of the Ottawa River. An ancient northern communication of the basin of the Ottawa River with Lake St-Jean would explain the presence in this last region of many isolated species, like *A. saccharophorum* and many of its associates in Metabetchouan, on the plain of Lake St-Jean. At all events, the lowlands of Northern Quebec and Ontario show some evi-

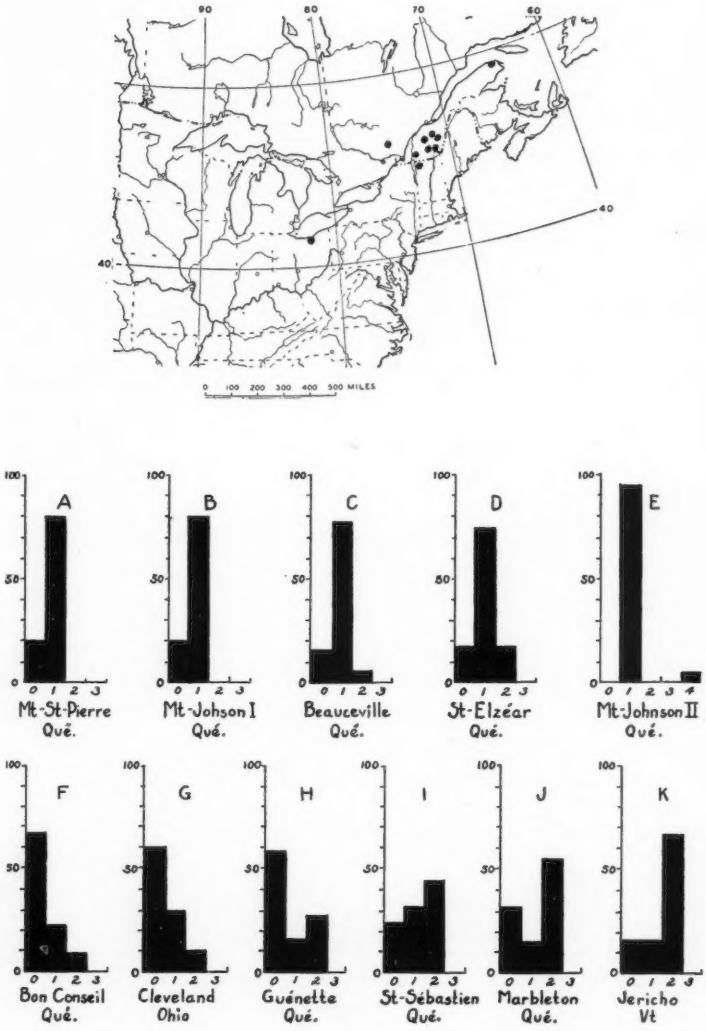

Fig. 4. Range and frequency distribution of pure colonies of *Acer saccharophorum* (0 = *saccharophorum*, 12 = *nigrum*).

TABLE 3.—Somewhat contaminated colonies of *Acer saccharophorum*, showing a tendency to reduction of outline. See fig. 5 A to F.

Index value	A Stornoway, Que.	B Plessisville, Que.	C St-Benjamin, Que.	D Lambton, Que.	E Jericho Corner, Vt.	F Carters Cave, Ky.
0	4 ADGJN	18 ADGJN	3 ADGJN	6 ADGJN	7 ADGJN	3 ADGJN
1		11 ADGJO 1 ADHJN 4 ADGKN	1 ADGJO 5 ADGKN	3 ADGKN 4 ADGJO	4 ADGKN 1 ADGJO	1 ADGJO
2	3 ADGKO	26 ADGKO	12 ADGKO	17 ADGKO	5 ADGKO	2 ADGKO
3	2 ADGLO	1 ADHKO 1 BDGKO 3 ADGLO 2 BDHJO	4 ADGLO	1 BDGKO	1 ADHKO 1 ADGLO	1 BDGKO
4				1 BEGKO		1 BEGKO
5			1 BDHLO			

dence of relatively warm and dry conditions and may well have served at one time as a northeastward migration route.

There are some *Acer nigrum* in the remaining colonies (table 5 and fig. 6, A to I) and many intermediate individuals. It is interesting to note that these colonies where the hybridization process appears to be most active still, are distributed along an axis intermediate between that of the two preceding groups: the appalachian (fig. 5, A to F) and the laurentian (fig. 5, H to N).

Discussion and Conclusions

The colonies have therefore been grouped into three categories. Fig. 4 shows pure colonies of *A. saccharophorum*, homogeneous populations which do not apparently pose any problem. Fig. 5 groups much more heterogeneous colonies, no single index-value being dominant: in fact as many as three or four attain approximately equal percentages. This lowering of dominance and movement of the values towards the right is due, however, to two distinct series of factors: a) colonies in which the leaves are somewhat pubescent; b) colonies in which the lobes tend to be reduced. Fig. 6 includes only colonies where the hybridization process appears to be active still.

A fourth series of graphs was obtained not from sampling populations but from herbarium specimens (presumably collected at random?) of two distinct

areas: Illinois (Herbarium of the University of Illinois) and New England (Herbarium of the New England Botanical Club) (Fig. 8).

The colonies of the first group—with only one exception—lie outside the present range of *A. nigrum* (Fig. 4). Indeed they show practically no signs of having been influenced—even in former times—by that species. However, in the other colonies (fig. 5), it is interesting to note that *nigrum* influence—if such it is—has behaved somewhat differently in the Great Lakes-Canadian shield area (fig. 5, H to N) where the movement to the right and the flattening of the curve are due to pubescence, and in the Appalachian arc (fig. 5, A to F) where the same effect is rather due to reduction of lobes. One is tempted to think of a prevalence of comparative dryness and cold in the first case and of comparative humidity and heat in the second.

TABLE 4.—Somewhat contaminated colonies of *Acer saccharophorum* showing a tendency to increase in pubescence. See fig. 5 G to N.

Index value	G Brownfield Woods, Ill.	H Lac des Loups, Que.	I Val Barrette, Que.	J N. of Montlaurier, Que.	K Lac Roland, Que.	L South Temiskaming, Que.	M Mattawa, Ont.	N Metabetchouan, Que.
0	1 ADGJN	8 ADGJN	3 ADGJN	3 ADGJN	7 ADGJN	4 ADGJN	6 ADGJN	18 ADGJN
1	3 BDGJN 1 ADGKN	1 BDGJN 1 ADGKN	3 ADGKI	5 BDGJN 2 ADHJN	2 ADGJO 1 ADHJN	3 ADGKN 3 ADGJO 1 ADHJN	4 ADGJO 2 ADHJN 2 ADGKN	6 ADGJO 4 ADGKN 2 ADHJN
2	1 ADGKO 1 BDGJO 1 BEGJN	1 BDHJN 31 ADGKO	4 ADGKO 1 BDHJN 1 ADHJO	1 BEGJN 3 BDHJN 3 ADHJO	5 ADGKO 1 BDHJN	17 ADGKO 2 BDHJN 1 ADHJO	13 ADGKO 1 BDGJO	18 ADGKO 1 ADHKN
3	1 BDHJO	1 BEHJN 2 ADGLO 1 BDGKO 1 ADHKO	3 ADGLO 1 BDHJO 1 BEHJN	1 BDHJO 1 ADGLO 1 BEHJN 1 BDHKN	1 ADGLO 2 BEHJN	2 BDGKO 9 BEHJN 1 BDHJO 2 ADHKO	1 ADGLO 2 ADHKO 2 BEHJN 1 BDGKO	2 ADHKO 1 BEHJN
4				1 BDHKO	1 BEHKN	5 BEHJO 4 BEGKO 5 BDHKO 1 ADHLO 2 BEHKN	1 BEHJO	1 BDHKO 1 ADHLO 1 BEHKN
5				1 BEHKO	1 BEHKO	2 BDHLO 11 BEHKO 1 BEGLO	4 BEHKO	2 BEHKO
6						1 BEHLO	4 CEHKO	

Amongst the hybrid colonies (fig. 6), the Quebec populations show two very distinct summits, implying the immediate presence of hybridization. The Illinois colonies are in a decidedly more advanced stage. In fact, there is little difference between fig. 6 I and fig. 5 M.

The final graphs (fig. 8) bring out regional differences between a cold-moist climate (New England) and a relatively warmer-drier one (Illinois).

TABLE 5.—Colonies with a wide range of index values, showing hybridization still at work. See fig. 6.

Index value	A St-Francois-de-Sales, Que.	B Saraguay, Que.	C St-Eustache, Que.	D Grenville, Que.	E St-Lin I, Que.	F St-Lin II, Que.	G Brownfield Woods, Ill.	H Kickapoo Park, Ill.	I Trelease Woods, Ill.
0	6 ADGJN	3 ADGJN	3 ADGJN	7 ADGJN	13 ADGJN	15 ADGJN		2 ADGJN	
1	17 ADHJN	29 ADHJN		10 ADGJO	2 ADGJO 3 ADHJN 2 ADGKN	15 ADGJO	1 ADGKN	1 BDGJN 1 ADGJO	2 ADGKN 2 BDGJN-
2	2 ADHJO 1 ADHKN	1 ADGKO 3 ADHJO	1 ADGKO	13 ADGKO	4 ADGKO 1 ADHJO	5 ADGKO 1 ADHKN 1 ADHJO	2 BDGJO 3 BDHJN 1 BDGKN	6 BDGKN 1 ADGLN 3 ADGKO	5 BDGKN 1 ADGKO
3		2 ADIJO		1 ADGLO	1 BEHJN 2 ADHKO	1 ADGLO 1 BDGKO 1 ADHKO	3 BDGKO 2 ADGLO	8 BDGKO 2 ADGLO	6 BDGKO 8 ADGLO 1 BDHJO
4	1 BEHJO	2 BEHJO	1 ADHLO	1 BEHJO 1 BEGKO	1 BEGKO		1 BDGLO 1 BEHJO 1 CEHJN	2 BDGKP 3 BDGLO 1 ADGLP	12 BDGLO
5		7 BEHMP 1 BEHKO	1 ADHLP	2 BEHKO 1 BFGKO	2 BEHKO 1 BDIKO			1 BDHLO	1 BDGLP
6	1 BEHLO	1 BEHKP 1 BEHLO 1 BEIJP 10 BEIKO 1 BFIJO 4 CEIJO	1 AEHLP	4 BFHKO 2 BFGLO	1 BFHKO		1 CEHKO		2 BDGMO
7		2 BEIKP 1 BEILO 1 CEIKO		3 CFHKO	1 CFHKO 1 BFHLO	1 BEHLP		4 BDILP	1 BDGMP
8	1 BEILP	2 BEILP 1 CEILO 1 CEIKP	2 CEILO	1 CFHKP 4 CFIKO	1 CFIKO 1 CEIKP	1 BFHLP 1 CFIKO			
9	1 BEHMP		2 CEILP 5 BEHMP	1 BEHMP	3 CFILO	3 CFILO		5 BDIMP	
10	1 BEIMP				1 CFILP				

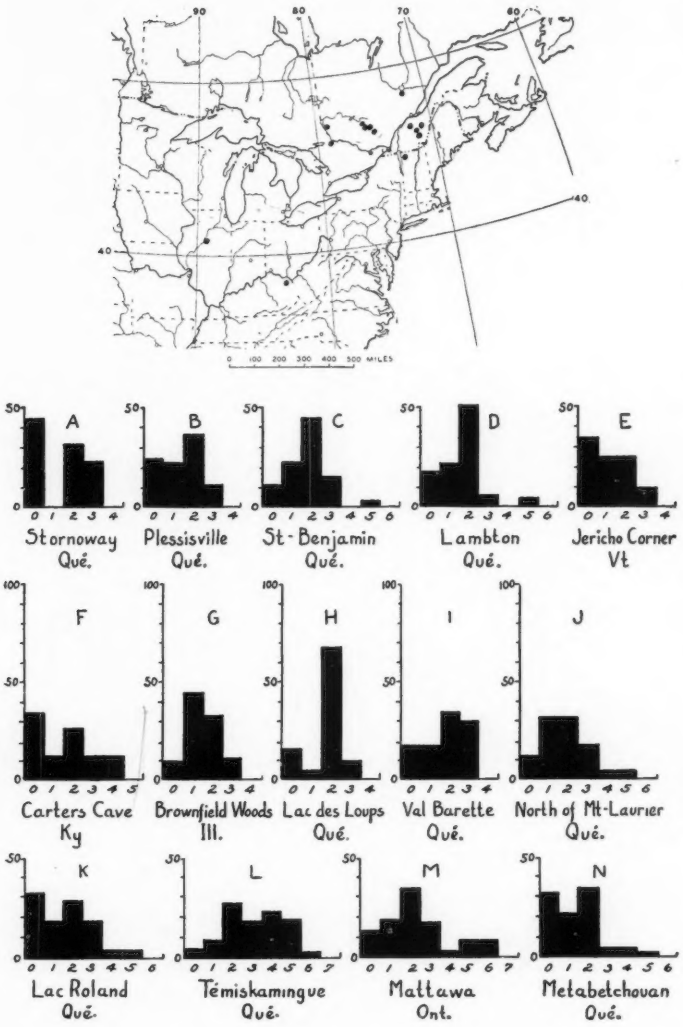

Fig. 5. Range and frequency distribution of somewhat contaminated colonies of *Acer saccharophorum* (0 = *saccharophorum*, 12 = *nigrum*).

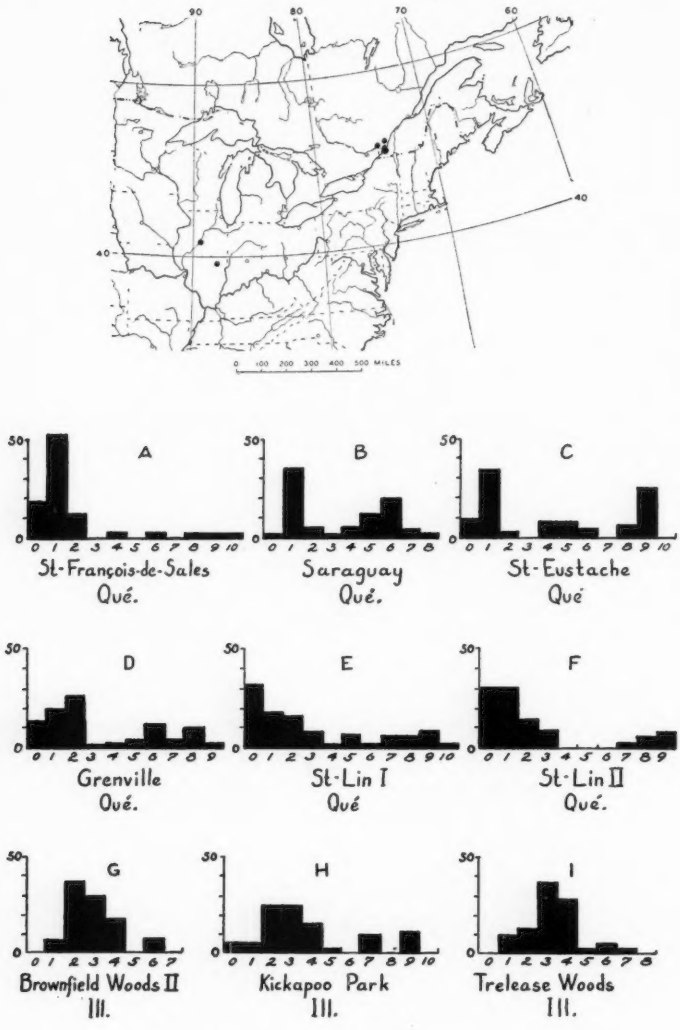

Fig. 6. Range and frequency distribution of hybrid colonies of *Acer saccharophorum* (0 = *saccharophorum*, 12 = *nigrum*).

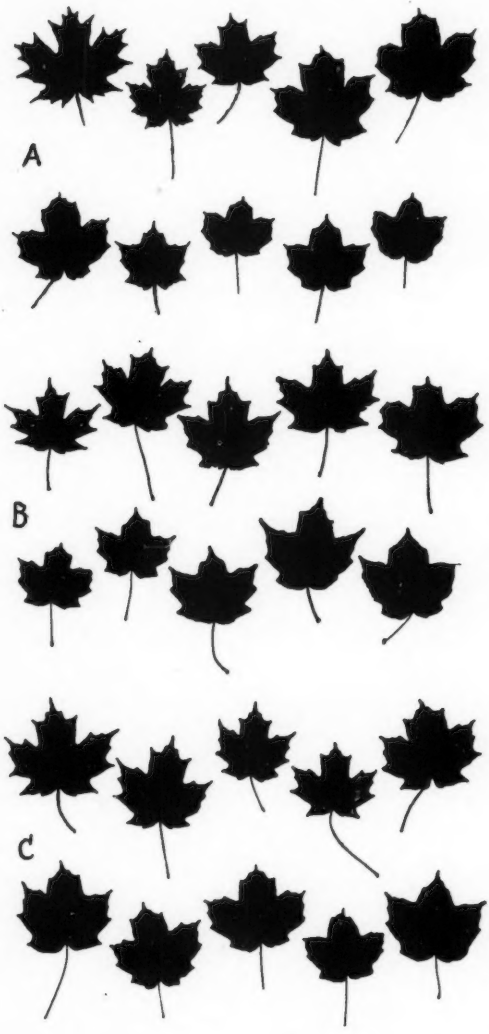

Fig. 7. Leaves from three colonies, showing intermediates in the outline of the leaves. A. Saraguay, Quebec. See fig. 6B and table 5B. B. Grenville, Quebec. See fig. 6D and table 5D. C. Trelease Woods, Illinois. See fig. 6I and table 5I. Photo Lucien Lévesque, c.s.c.

We therefore maintain that there is hybridization between *A. saccharophorum* and *A. nigrum*. Sargent (18) had noticed this. In his "Sylva" he writes: "Extreme forms of the Black Maple . . . are easily recognized and appear distinct, but they seem to pass gradually by many intermediate forms into the plant which is usually regarded as the type of the species. . . ." Marie-Victorin (14) had also pointed out hybridization in the Quebec sugar maples.

Some of the colonies show many intermediates between the two extreme types, as much in the pubescence as in the outline of the leaves (fig. 7).

Furthermore, in measurements made on herbarium specimens, we have found all the intermediate indexes from 0 to 11 (fig. 8).

There seems to be no correlation between the outline of the leaf (more or less lobes) and the pubescence. This is shown in the diagram in figure 9, made from 1140 leaves. We had leaves with only 3 to 6 lobes, and entirely glabrous; also leaves very dissected with a strong pubescence.

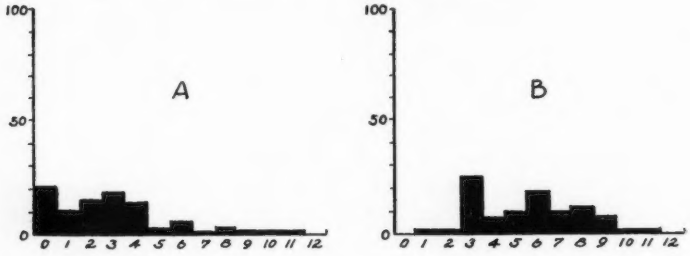

Fig. 8. Frequency distribution of herbarium specimens of *Acer saccharophorum*. A = New England Botanical Club. B = University of Illinois. (0 = *saccharophorum*, 12 = *nigrum*).

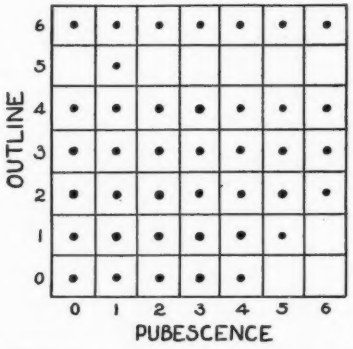

Fig. 9. Correlation between the pubescence and the outline of *Acer saccharophorum* leaves according to the index values of table 1.

The numerous forms and varieties described by many authors, based on the shape of the leaf and its pubescence should be studied statistically, ecologically and geographically in order to see if they are valid entities or only exceptional forms of the same species.

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REFERENCES

1. ANDERSON, EDGAR. 1936—Hybridization in American *Tradescantias*. I. A method for measuring species hybrids. II. Hybridization between *Tradescantia virginiana* and *T. canaliculata*. Ann. Mo. Bot. Gard. **23**:511-525.
2. ———1939—Recombination in species crosses. Genetics **24**:668-678.
3. ——— AND LESLIE HUBRICHT. 1938—Hybridization in *Tradescantia*. III. The evidence for introgressive hybridization. Amer. Journ. Bot. **25**:398-403.
4. ——— AND ———. 1938—The American Sugar Maples. I. Phylogenetic relationships as deduced from a study of leaf variation. Bot. Gaz. **100**:312-324.
5. ——— AND R. E. WOODSON. 1935—The species of *Tradescantia* indigenous to the United States. Arn. Arboret. Contrib. **9**:7-132.
6. BRAUN-BLANQUET, J. 1932—Plant sociology. xviii+439 pp. McGraw-Hill Book Company, New York.
7. CAIN, S. A. 1944—Foundations of Plant Geography. xiv+456 pp. Harper and Brothers, New York.
8. DANSEREAU, PIERRE. 1938—Etudes sur les hybrides de cistes. III. Statisque des caractères du *Cistus monspeliensis*. Bull. Soc. Bot. France, **85**:668-678.
9. ———1941—Etudes sur les hybrides de cistes. IV. Corrélation des caractères du *C. salviifolius* L. VI. Introgression dans la section Ladanium. Contrib. Inst. Bot. Univ. Montréal **38**.
10. ———1944—Les érablières de la Gaspésie et les fluctuations du climat. Contrib. Inst. Bot. Univ. Montréal **51**.
11. ——— ET ANDRÉ LAFOND. 1941—Introgression des caractères de *l'Acer saccharophorum* K. Koch et de *l'Acer nigrum* Michx. Contrib. Inst. Bot. Univ. Montréal **37**:15-31.
12. GOODWIN, R. H. 1937—The cyto-genetics of two species of *Solidago* and its bearing on their polymorphy in nature. Amer. Journ. Bot. **24**:425-432.
13. LARISEY, M. M. 1940—Analysis of a hybrid complex between *Baptisia leucantha* and *Baptisia viridis* in Texas. Amer. Journ. Bot. **27**:627-628.
14. MARIE-VICTORIN, F. 1935—Flore laurentienne. 916 pp. Imp. De La Salle, Montréal.
15. ——— ET F. ROLLAND-GERMAIN. 1942—Première observations botaniques sur la nouvelle route de l'Abitibi. Contrib. Inst Bot. Univ. Montréal **42**.
16. ——— ET JACQUES ROUSSEAU. 1940—Nouvelles entités de la flore phanérogamique du Canada oriental. Contrib. Inst. Bot. Univ. Montréal **36**.
17. RILEY, H. P. 1938—A character analysis of colonies of *Iris fulva, Iris hexagona* var. *giganticaerulea* and natural hybrids. Amer. Journ. Bot. **25**:727-738.
18. SARGENT, C. S. 1891—The Silva of North America. Vol. 2, 117 pp. 97 plates. Houghton Mifflin & Co., River Side Press, Cambridge, Boston & New York.
19. WETMORE, R. H. AND A. L. DELISLE. 1939—Studies in the genetics and cytology of two species in the genus *Aster*. Amer. Journ. Bot. **26**:1-12.

Contrasts in the Vegetation of Sierra Tierra Vieja in Trans-Pecos Texas

L. C. Hinckley

Introduction

In western Presidio and Jeff Davis Counties of Trans-Pecos Texas there lies a long mountain range paralleling the Rio Grande and extending toward the Big Bend of that river. On recent maps the range is designated as the Tierra Vieja Mountains, but on early geological maps it bears the name Sierra Vieja or Sierra Vieja Mountains. Consistency in the use of Spanish would suggest the name Sierra Tierra Vieja, old earth mountain, and the range will thus be referred to in this paper.

Geology and Topography

Properly speaking, Sierra Tierra Vieja is not a mountain, and it is not old as geological formations go. The main feature of the range is an escarpment capped by lava of rare quartz-pantellerite (Baker, 1927). This escarpment, the Rimrock or Rim as it is designated by the local ranchers, consists of west-facing cliffs varying in height from a few feet to several hundred (Fig. 1). The opposite flank is an eastward tipping slope of relative steepness, the middle part of the main cuesta descending from a height of 6467 feet at Vieja to less than 5000 feet some five miles eastward.

The lava flow forming Sierra Tierra Vieja dates to early Tertiary time. Mid-Tertiary deformational movements produced a fault extending the length of the range, more than fifty miles, and forming its structural summit (Baker, 1935). In the central section of the range a broad zone of parallel and

Fig. 1.—Vieja, the high point of the main cuesta of Sierra Tierra Vieja. In the left distance is a lower part of the range, an offshoot extending southward from Vieja Pass.

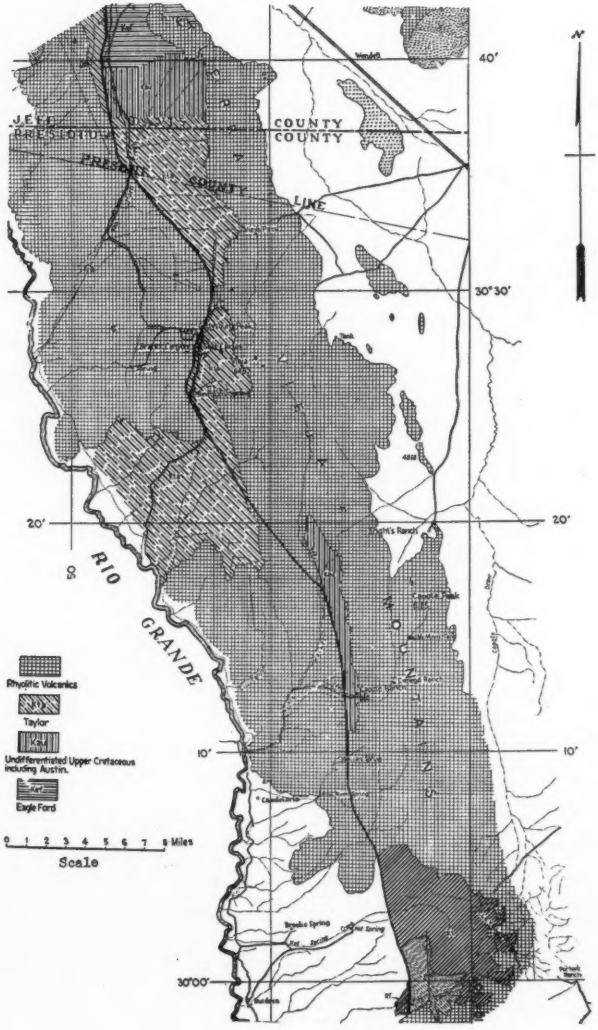

Fig. 2.—Geological map of Sierra Tierra Vieja. (Adapted from map from University of Texas Bulletin 2745).

sub-parallel faults and the action of various erosive agents have formed the other noticeable relief features. A series of lesser peaks and ranges extending southwestward from near Vieja Pass separate the valley of Van Horn Creek and its tributaries from the San Carlos Valley (Fig. 2). It will be noted from the map that in both of these valleys there are large areas of two late Cretaceous formations, the Taylor and an undifferentiated formation consisting mostly of the Austin. About five miles south of Vieja another series of escarpments branches off southward from the main cuesta. Still further south the latter plunges underground; and the eastern cuesta, with Capote Peak as its northern end, becomes the main structural feature. The eastern cuesta with the lower escarpments mentioned above form the Walker Creek-Capote Creek Valley, which breaks out through a narrow aperture into the Rio Grande near the southern end of the range. A narrow strip of the late Cretaceous formation similar to that in the upper Van Horn Valley may be noted along the eastern side of the fault in the Walker Creek-Capote Creek Valley.

The foot of the eastern side of Sierra Tierra Vieja is bordered along its full length by a northward flowing drainage system made up of Capote Draw and Chispa Creek. On the western side of the range the terraced buttes and mesas extend to the banks of the Rio Grande, forming, with somewhat similar mountains on the Mexican side of the river, a narrow valley for a distance of several miles north of Candelaria (Fig. 3). The area west of Van Horn Creek in the western tips of Presidio and Jeff Davis Counties is geologically a part of the Mexican overthrust and is not considered in this study.

Fig. 3.—The valley of the Rio Grande about five miles above Candelaria, the Texas side on the left. The trees bordering the banks of the river are salt cedar (*Tamarix gallica* L.). Mesquite (*Prosopis juliflora* (Swartz) DC.) makes up most of the remaining cover in the valley.

Botanical History

Few botanists have entered the wild area covered by Sierra Tierra Vieja. Charles Wright, whose plant collecting in southwestern Texas was sponsored by Gray, passed close to the range in 1849 with a surveying party of army engineers (Wooton, 1906). A party of the U. S.-Mexican Boundary Survey traveled up the Rio Grande from the present town of Presidio to El Paso about 1852 (Emory, 1857-59). The collectors of the Boundary Survey apparently penetrated some distance into the range from the Rio Grande side, probably following the creek valleys. Nealley skirted the southern end of the range on a trip into the Chinati Mountains about 1887 (Nealley, 1888). Dr. M. S. Young of the University of Texas traveled by burro-drawn buggy along the old stage route through the Brite ranch and over the Rimrock to Candelaria and Hot Springs in the fall of 1914 (Young, 1914). It is doubtful whether any botanists other than the writer has penetrated deeply into the range from both the east and the west. Only occasional references can be found in botanical literature about the vegetation of the area.

Present Study

The present study was begun in the spring of 1941 and was continued through the succeeding years, ending in the late fall of 1944. Intensive collecting in the rather wet year of 1941 resulted in almost complete coverage of the range. Later trips for collecting and note taking left only a few spots in the semi-desert area below the Rimrock that were not visited. The lists of collections made are representative of the contrasting divisions of study.

Climatological Data

The eight-year records of the Weather Bureau station on the Espy Miller ranch just east of Vieja Pass probably come near to giving the average rainfall for the area (Table 1). It will be seen that 1941 with an annual precipitation of 25.98 inches was well above the average for the period, 14.69 inches. The year 1939 shows an annual average of 10.61 inches, which is considerably below the eight-year average.

Records at the Marfa Office of the Soil Conservation Service, U. S. Department of Agriculture, cover only three years, a period too short to give conclusive evidence about average rainfall. However, gauges at the Bunton and Brite ranches about fifteen and eighteen miles, respectively, in a southerly direction from the Espy Miller station recorded averages that correspond to the Weather Bureau readings. Each of the Soil Conservation stations showed almost twenty-four inches of precipitation in 1941. Since all of these stations are along the eastern foot of the range, a twelve to fifteen inch annual average rainfall may be assumed for the lower slopes on that side.

No data are available for the higher slopes, but the annual average is undoubtedly higher than that of the lower eastern slopes. It is reasonable to assume an average of eighteen to twenty inches for the area around Vieja at

TABLE 1.—Precipitation at Espy Miller Ranch: Average Monthly and Annual Amounts in Inches and Hundredths.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1937	0.00	0.36	0.20	0.13	1.05	0.85	0.61	2.22	3.15	2.13	0.61	1.05	12.36
1938	0.59	0.54	0.15	0.27	0.00	3.27	5.20	1.48	3.85	1.22	0.00	0.50	17.07
1939	1.19	0.00	0.49	0.16	0.41	0.89	1.83	2.57	0.56	1.29	0.93	0.29	10.61
1940	0.79	0.36	0.24	0.12	1.25	1.42	1.22	2.88	0.57	1.84	1.31	0.59	12.59
1941	0.76	0.91	0.79	1.87	3.04	2.92	2.82	3.11	5.24	3.77	0.20	0.55	25.98
1942	0.45	0.27	0.24	0.97	0.18	1.85	1.35	4.03	0.52	1.23	0.25	0.47	11.81
1943	0.33	0.00	0.10	0.00	0.53	4.62	1.52	0.46	2.10	0.00	1.30	1.67	12.63
1944	1.12	0.93	0.00	0.00	0.37	3.57	1.76	1.54	3.56	0.28	0.53	0.85	14.51
Average	0.65	0.42	0.28	0.44	0.85	2.42	2.04	2.29	2.44	1.47	0.64	0.75	14.69

the summit of the main cuesta. Whatever the rainfall on the eastern slope, it is sufficient to keep a half dozen canyons originating there well watered in all but the extremely dry years.

The semi-desert lands along the western side of the range have less rainfall than the lower eastern slope. An estimated figure would be a mere guess, but most parts of the area below the Rimrock must have an average of less than ten inches of rainfall per year. There are few springs and these have a limited flow.

Temperature data are not available for any part of the range. The records of the McDonald Observatory on Mount Locke almost fifty miles east of the northern end of Sierra Tierra show an average of about 200 days between the latest killing freeze in the spring and the earliest killing freeze in the fall (Table 2). Vieja, with an altitude of 6467 feet as compared to 6791 feet on Mount Locke, could be expected to have an average of more than 200 days free from killing freezes. Such an average would amount to about seven months for the upper slopes of the range. The writer has observed that in parts of the area below the Rimrock many plants will stay green for ten or eleven months of the year.

TABLE 2.—Length of Time in Days between Killing Frosts at McDonald Observatory, Mount Locke.

Year	Last of Spring	First of Autumn	Days
1936	April 8	September 29	174
1937	April 8	November 26	232
1938	April 9	October 20	194
1939	March 29	October 30	215
1940	April 18	November 11	207
1941	April 19	October 31	195
1942	April 24	October 19	178
1943	March 25	November 7	227
1944	April 3	November 16	227
Average number of days			205

The limiting factor in plant growth is the small amount of rainfall. About three-fourths of the annual precipitation occurs in the five months from June through October. Infrequently, as in the wet year of 1941, the rainfall is sufficient to keep the vegetation green from April well into November. There are other years when plant growth is limited to a few weeks, occasionally two short growing seasons occurring in the same year with a dry mid-summer between them.

Vegetation

Chiefly because of the differences in rainfall the vegetation of the area presents some striking contrasts. The eastward sloping side of the range can be designated as grassland, hairy grama (*Bouteloua hirsuta* Lag.) being the

dominant species at middle and upper elevations (Fig. 4). Wolftail (*Lycurus phleoides* H.B.K.) occurs on the somewhat dry exposed spots at the same elevations. Two beardgrasses (*Andropogon cirratus* Hack. and *A. hirtiflorus* var. *feensis* (Fourn.) Hack.) are found along the edge of the Rimrock, sometimes on both north and south slopes of the high points. On dry rocky slopes at middle elevations of the eastern slope black grama (*Bouteloua eriopoda* Torr.) and sprucetop grama (*Bouteloua chondrosioides* (H.B.K.) Benth.) occur separately. Blue grama (*Bouteloua gracilis* (H.B.K.) Lag.) is found

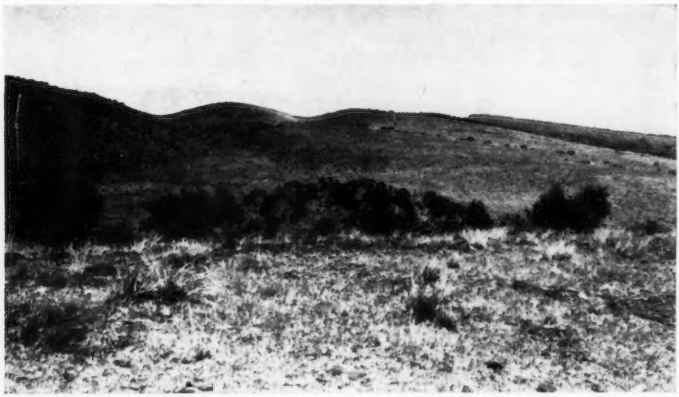

Fig. 4.—The high east slope at Vieja. The trees on the slopes are the gray oak (*Quercus grisea* Liebm.). In the foreground are specimens of the Emory oak (*Quercus emoryi* Torr.), tree cactus (*Opuntia arborescens* Engelm.), and the one-seeded juniper (*Juniperus monosperma* (Engelm.) Sarg.) on the eastern bluff of Knox Canyon.

Fig. 5.—Lechuguilla (*Agave lechuguilla* Torr.) flowering profusely on a slope at Vieja Pass.

frequently along the eastern slope of the range, the hills at the southern end having a good cover of this species. The lower foothills in that area show considerable cover of cane beardgrass (*Andropogon barbinodis* Lag.)

Due probably to folding and erosion a series of high points has been formed in the region of Vieja (Fig. 4). As is commonly found in the mountains of southwestern Texas (Cottle, 1932), these high points show contrasting areas of vegetation. The gray oak (*Quercus grisea* Liebm.) gives a thin cover to the north slopes, straggling specimens sometimes appearing over the apex of the hill or a number of trees forming a distinct line above the bottom of the trough between the points on the south slope. A similar condition is found in the oak-capped hills at the southern end of the eastern cuesta. The higher points of the range thus approach a woodland climax.

Along the edge of the Rimrock a thin line of shrubs, evergreen sumac (*Rhus virens* Lindh.) and shrubby trefoil (*Ptelea baldwinii* Torr. & Gray), overhangs the high cliffs in stunted thickets. At the tips of a few of the highest points there are scattered shrubs of mountain mahogany (*Cercocarpus breviflorus* Gray). Occasional specimens of the Emory oak (*Quercus emoryi* Torr.) are found on the ledges of the upper canyons and near the heads of the middle canyons, and solitary plants of the tree cactus (*Opuntia arborescens* Engelm.) and the one-seeded juniper (*Juniperus monosperma* (Engelm.) Sarg.) dot the landscape. The lower part of the slope, having less rainfall than the higher parts, often shows lechuguilla (*Agave lechuguilla* Torr.) (Fig. 5) sotol (*Dasylirion leiophyllum* Engelm.), and sacahuiste (*Nolina texana* Wats.) in abundance in small areas. Exposed slopes at the southern end of the range often have large spots of the nearly leafless buckthorn (*Adolphia infesta* Meisn.).

The list of plants collected on the eastern slopes of the main cuestas from the summit of the Rimrock to the lower elevations on the eastern foot of the range shows a number of species that can be found covering large areas, species which have not been previously mentioned. The complete list of collections is herewith given.

TREES

Juniperus monosperma (Engelm.) Sarg.
Quercus emoryi Torr.
Quercus grisea Liebm.

SHRUBS

Acacia constricta Benth.
Acacia cuspidata Schlecht.
Acacia greggii Gray
Adolphia infesta Meisn.
Agave lechuguilla Torr.
Agave scabra Salm-Dyck
Baccharis pteronioides DC.
Bouvardia ternifolia (Cav.) Schlecht.
Buddleia scordioides H.B.K.
Cercocarpus breviflorus Gray
Dasylirion leiophyllum Engelm.
Echinocactus horizonthalonius Lemaire
Echinocereus viridiflorus Engelm.
Fendlera rupicola Gray
Garrya ovata Benth.
Mamillaria meiacantha Engelm.
Microrhamnus ericoides Gray
Opuntia arborescens Engelm.
Ptelea baldwinii Torr. & Gray
Rhus choriophylla Woot. & Standl.
Rhus microphylla Engelm.
Rhus virens Lindh.
Yucca torreyi Shafer

FORBS

Actinea scaposa var. *linearis* (Nutt.) Rob.
Amaranthus retroflexus L.
Anthericum torreyi Baker
Arabis fendleri (Wats.) Greene
Artemisia gnapholodes Nutt.
Asclepias glaucescens H.B.K.
Asclepias latifolia (Torr.) Raf.
Asclepias nummularia Torr.
Asclepias subverticillata (Gray) Vail
Asclepiodora decumbens (Nutt.) Gray
Berlandiera lyrata Benth.
Brickellia cylindracea Gray & Engelm.
Calliandra humilis Benth.
Castel'eja integra Gray
Chrysopsis viscida (Gray) Greene
Cirsium ochrocentrum Gray
Commelina dianthifolia Delile
Convolvulus incanus Vahl
Dichondra argentea Willd.
Ditaxis neomexicana (Muell. Arg.) Heller
Dyschoriste linearis (Torr. & Gray) Kuntze
Dyssodia thurberi (Gray) Wats.
Erigeron nudiflorus Buckl.
Eriogonum jamesii Benth.
Eriogonum wrightii Torr.
Eupatorium wrightii Gray
Euphorbia dentata Michx.
Evolvulus discolor Benth.
Galactia wrightii Gray
Gaura coccinea Pursh
Grindelia aphanactis Rydb.
Gutierrezia lucida Gray
Hedeoma plicatum Torr.
Heliopsis parvifolia Gray
Heterospermum pinnatum Cav.
Houstonia angustifolia Michx.
Ipomoea costellata Torr.
Ipomoea lindheimeri Gray
Kuhnia rosmarinifolia Vent.
Liatris punctata Hook.
Linum aristatum Engelm.
Lotus rigidus (Benth.) Greene
Lygodesmia texana (Torr & Gray) Greene
Macrosiphonia macrosiphon (Torr.) Heller
Melampodium leucanthum Torr. & Gray
Menodora scabra Gray
Metastelma palmeri (Wats.)
Mirabilis linearis (Pursh) Heimerl
Mirabilis oxybaphoides Gray
Nolina texana Wats.
Oenothera brachyptera var. *wrightii* (Gray) Levl.
Oenothera greggii Gray
Parosela aurea (Nutt.) Britt.
Parosela frutescens (Gray) Vail
Parosela nana (Torr.) Heller
Penstemon barbatus var. *torreyi* (Benth.) Gray
Penstemon fendleri Gray
Perezia wrightii Gray
Peteria scoparia Gray
Phlox mesoleuca Greene
Pinaropappus roseus Less.
Psilostrophe tagetinae (Nutt.) Greene
Psoralea tenuiflora Pursh
Rhynchosia texana Torr. & Gray
Schkuhria hopkirkia Gray
Sedum wrightii Gray
Senecio longilobus Benth.
Senecio riddellii Torr. & Gray
Sida neomexicana Gray
Solanum rostratum Dunal
Solidago sparsifolia Gray
Sphaeralcea subhastata Coult.
Thelesperma megapotamicum (Spreng.) Kuntze
Tragia nepetaefolia Cav.
Verbena neomexicana (Gray) Small
Viguiera cordifolia Gray
Xanthium spinosum L.
Zinnia grandiflora Nutt.

GRASSES

Andropogon barbinodis Lag.
Andropogon cirratus Hack.
Andropogon hirtiflorus var. *feensis* (Fourn.) Hack.
Aristida wrightii Nash
Bouteloua chondrosioides (H.B.K.) Benth.
Bouteloua curtipendula (Michx.) Torr.
Bouteloua eriopoda Torr.
Bouteloua gracilis (H.B.K.) Lag.
Bouteloua hirsuta Lag.
Bromus anomalus Rupr.
Elyonurus barbiculmis Hack.
Eragrostis erosa Scribn.
Eragrostis palmeri Wats.
Heteropogon contortus (L.) Beauv.
Hilaria berlangeri (Steud.) Nash
Koeleria cristata (L.) Pers.
Lycurus phleoides H.B.K.
Muhlenbergia glauca (Nees) Mez
Muhlenbergia monticola Buckl.
Muhlenbergia rigida (H.B.K.) Kunth
Panicum hallii Vasey
Panicum obtusum H.B.K.
Setaria grisebachii Fourn.
Stipa eminens Cav.

Near the head of Musgrave Canyon on the main cuesta there is a pinon-juniper association consisting of some 100 to 150 specimens of the Mexican pinon (*Pinus cembroides* Zucc.) and less than half that number of the alligator juniper (*Juniperus pachyphloea* Torr.) (Fig. 6). Seeing this isolated plant group, one is inclined, without being able to give additional valid data, to a firmer belief in the relic theory as an explanation for the existence of the species here. Thirty miles to the northeast the alligator juniper occurs at an elevation of 6000 to 8000 feet in the Davis Mountains (Hinckley, 1944). It is about the same distance southward where the writer collected the same species on the northeast slope of Chinati Peak at an altitude of 6500 feet to 7200 feet. The elevation of the slope where the trees grow in Sierra Tierra Vieja is from 5600 to 5800 feet. The Mexican pinon has been reported by the men of the Marfa Soil Conservation Service to be on Little or West Chinati Peak. Associated with these species in the range under study are numerous clumps of the Texas madrona (*Arbutus texana* Buckl.), which has not been found in any other part of the range. Since these species have been collected at only the one spot, they will not be listed among the plants of the canyons, a discussion of which now follows.

Since the canyons on the eastern side of the main cuesta are well watered, it is natural to expect various kinds of trees (Fig. 7). Four of these canyons, ZH or Holland, Knox, Joe Sitter's, and Grapvine, have almost identical types of vegetation and will be considered as a unit. An interesting tree found in all of these canyons is the bigtooth maple (*Acer grandidentatum* Nutt.). The specimens grow to a larger size and appear more healthy here than at any other place the writer has seen them in Texas. Another attractive tree of these canyons is the ash (*Fraxinus velutina* Torr.), which, while not growing to its maximum size, is well established. The Arizona grape (*Vitis arizonica*

Fig. 6.—A view of the upper slopes 2-3 miles south of Vieja. Note the Mexican pinon (*Pinus cembroides* Zucc.) and alligator juniper (*Juniperus pachyphloea* Torr.) in center of picture.

Engelm.) is so numerous here that any one of the canyons might be called Grapevine Canyon, and one of them, in fact, is known locally by that name.

A general description of the trees and shrubs from its mouth to its head will fit any of the main canyons on the eastern side of Sierra Tierra Vieja. At the mouth and for some distance upward the Emory oak grows to its largest size, some trees being two feet in diameter. This species forms an almost complete cover here. Above this where running water is found the bigtooth maple, the ash, and various species of willow (*Salix lasiolepis* Benth., *S. gooddingii* var. *vallicola* (Dudley) Ball, and *S. interior* var. *angustissima* (Anders.) occur. The native walnut (*Juglans rupestris* Engelm.) is frequent and of large size along the water courses, but no specimens that might be considered var. *major* Torr. are found.

As the walls of the canyon become less steep and there is more exposure to the sun, the gray oak becomes more numerous. On dry slopes of the canyon sides the one-seeded juniper (Fig. 8), the Mexican buckeye (*Ungnadia speciosa* Endl.), and an occasional chilicothe bush (*Sophora secundiflora* Lag.) are noticeable.

The list of collections includes a notable number of ligneous species.

TREES

Acer grandidentatum Nutt.
Celtis reticulata Torr.
Fraxinus velutina Torr.
Juglans rupestris Engelm.
Juniperus monosperma (Engelm.) Sarg.
Prunus virens (Woot. & Standl.) Shreve
Quercus emoryi Torr.
Quercus grisea Liebm.
Salix gooddingii var. *vallicola* (Dudley) Ball
Salix interior var. *angustissima* (Anders.)
Salix lasiolepis Benth.

Fig. 7.—Joe Sitter's Canyon. The bare looking strip is Joe Sitter's abandoned farm. His old cabin is under the grove of trees near the center. The wide spreading trees are the Emory oak.

SHRUBS

Acacia greggii Gray
Berberis trifoliata Moric.
Bouvardia ternifolia (Cav.) Schlecht.
Celtis pallida Torr.
Condalia lycioides (Gray) Web.
Croton fruticulosus Engelm.
Garrya wrightii Gray
Mimosa biuncifera Benth.
Opuntia engelmanni Salm-Dyck
Phoradendron bolleanum (Seem.) Eichl.
Phoradendron coryae Trel.
Philadelphus serpyllifolius Gray
Rhus choriophylla Woot. & Standl.
Rhus trilobata Nutt.
Sageretia wrightii Wats.
Sophora secundiflora Lag.
Ungnadia speciosa Endl.

LIANAS

Lonicera albiflora var. *dumosa* (Gray) Rehder
Vitis arizonica Engelm.

FORBS

Abutilon incanum (Link) Sweet
Acalypha lindheimeri Muell. Arg.
Aplopappus gracilis (Nutt.) Gray
Aristolochia wrightii Seem.
Artemisia dracunculoides Pursh
Artemisia mexicana Willd.
Aster exilis Ell.
Boerhaavia gracillima Heimerl
Brickellia californica (Torr. & Gray) Gray
Brickellia cylindracea Gray & Engelm.
Carex hystricina Muhl.
Cassia leptadenia Greenm.
Cirsium undulatum (Nutt.) Spreng.
Clematis pitcheri Torr. & Gray
Commelina crispa Woot.
Commelina dianthifolia Delile
Conopholis mexicana Gray
Coreopsis cardaminefolia (DC.) Torr. & Gray
Cyclanthera dissecta (Torr. & Gray) Gray
Cyperus acuminatus Torr. & Hook.
Cyperus inflexus Muhl.
Cyperus laevigatus L.
Cyperus rusbyi Britt.
Cyphomeris gypsophiloides (Mart. & Gal.) Standl.
Desmodium neomexicanum Gray
Desmodium wrightii Gray
Erigeron canadensis L.
Erigeron divergens Torr. & Gray
Eriogonum tenellum Nutt.
Euphorbia havanensis Willd.
Gilia aggregata (Pursh) Don
Gomphrena nitida Rothr.
Houstonia angustifolia Michx.
Iresine heterophylla Standl.
Juncus dudleyi Wieg.?
Juncus torreyi Cov.
Lactuca ludoviciana (Nutt.) Riddell
Laphamia rupestris Gray
Linum rupestre Engelm.
Lythrum linearifolium (Gray) Small
Maurandya antirrhiniflora Humb. & Bonpl.
Nothoscordum bivalve (L.) Britt.
Pagesia vandellioides (H.B.K.) Pennell
Penstemon barbatus var. *torreyi* (Benth.) Gray
Penstemon wrightii Hook.
Perezia nana Gray
Perezia wrightii Gray
Phacelia congesta Hook.
Phaseolus atropurpureus DC.
Physalis hederaefolia Gray
Polanisia uniglandulosa (Cav.) DC.
Polygonum lapathifolium L.
Rhynchosia texana Torr. & Gray
Sida neomexicana Gray
Silene laciniata Cav.
Solanum nigrum L.
Solanum triquetrum Gray
Solidago sparsifolia Gray
Stachys bigelovii Gray
Talinum aurantiacum Engelm.
Talinum paniculatum (Jacq.) Gaertn.
Thelypodium linearifolium Wats.
Thelypodium micranthum Wats.
Tragia nepetaefolium Cav.
Vicia leavenworthii Torr. & Gray
Viguiera dentata (Cav.) Spreng.
Wissadula holosericea (Scheele) Garke

GRASSES

Andropogon barbinodis Lag.
Andropogon cirratus Hack.
Andropogon hirtiflorus var. *feensis* (Fourn.) Hack.
Aristida ternipes Cav.
Bouteloua curtipendula (Michx.) Torr.
Bromus purgans L.
Chloris virgata Swartz
Echinochloa colonum (L.) Link
Echinochloa crusgalli var. *mitis* (Pursh) Peterm.
Eragrostis erosa Scribn.
Leptochloa fascicularis (Lam.) Gray
Lycurus phleoides H.B.K.
Muhlenbergia emersleyi Vasey
Muhlenbergia monticola Buckl.
Muhlenbergia rigens (Benth.) Hitchc.
Panicum anceps Michx.
Panicum plenum Hitchc. & Chase
Paspalum publiflorum Rupr.
Setaria villosissima (Scribn. & Merr.) Schum.
Setaria viridis (L.) Beauv.
Trichachne californica (Benth.) Chase

While the vegetation below the Rimrock may have been grassland at some earlier time, most of it can now be denoted as desert shrub. Here are hundreds of acres of creosote bush (*Larrea tridentata* (DC.) Cov.) (Fig. 9). Mixed with this shrub in varying amounts is the ocotillo (*Fouquiera splendens* Engelm.). Other noticeable shrubs occurring with the creosote bush are the dagger, previously mentioned on the low slopes of the eastern side, mesquite (*Prosopis juliflora* (Swartz) DS.), and cat's-claw (*Acacia greggii* Gray). The valleys bordering the streams have these latter shrubs in plentiful numbers, some of the specimens becoming trees with trunks up to eight or ten inches in diameter. The cat's-claw sometimes replaces the creosote bush almost entirely on certain mesa-like alluvial rubble slopes. Other shrubs characteristic of the valleys are the small-leaved sumac (*Rhus microphylla* Engelm.), lotebush (*Condalia lycioides* (Gray) Web.), and shad scale or fourwing saltbush (*Atriplex canescens* (Pursh) Nutt.). Common in the creek beds are seepwillow (*Baccharis glutinosa* Pers.) and burrobrush (*Hymenoclea monogyra* Torr. &

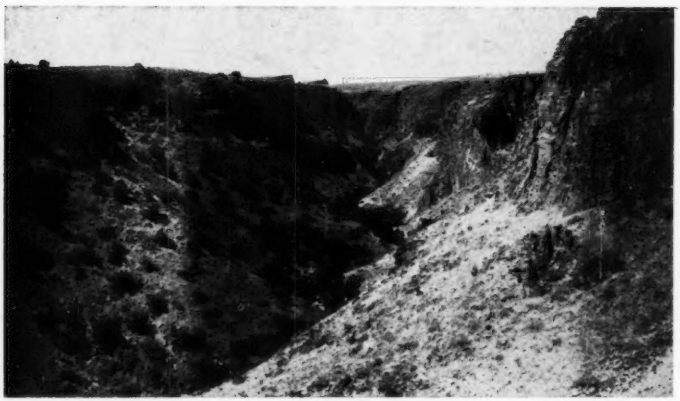

Fig. 8.—ZH Canyon from near the mouth to its bend. Note the one-seeded junipers on the southern slope.

Fig. 9.—Creosote bush (*Larrea tridentata* (DC.) Cov.) forms a large part of the vegetation below the Rimrock.

Gray). Typical of thin-soiled outwash or the little draws is the fragrant flowered acacia (*Acacia constricta* Benth.).

The canyons below the Rimrock are more open than those on the eastern slope. Chilicote is the common shrub, one canyon being so filled with it that it has become known locally as Chilicote Canyon. Thorny hackberry (*Celtis pallida* Torr.) and Mexican buckeye are common in the canyons and on the ledges of the lower foothills. Low foothills are often covered with candelilla (*Euphorbia antisyphilitica* Zucc.) and blood weed (*Jatropha spathulata* (Ort.) Muell. Arg.). In the wet year of 1941 the foothills and slopes not otherwise covered were beautifully green with holdfast grass (*Cathesticum erectum* Vasey and Hack.). In the Van Horn Valley near the upper end of the range and just below the Rimrock at Vieja Pass there are numbers of another dagger (*Yucca carnerosana* (Trel.) McKelvey). Sotol, lechuguilla, and basketgrass (*Nolina erumpens* (Torr.) Wats.) are common on exposed slopes. Also common in the drier parts of the area is the brown-spined prickly pear (*Opuntia phaeacantha* Engelm.), and tasajillo (*O. leptocaulis* DC.) is plentiful where there is alluvial soil whether along a small arroyo or in the larger valleys. The purple prickly pear (*O. macrocentra* Engelm.) is infrequent, but it gives an occasional and attractive bit of color to many spots in the area.

The list of plants collected includes several not expected in a desert shrub climax. The springs and the Rio Grande account for the species in the following groups that are water loving.

TREES

Populus wislizeni (Wats.) Sarg.
Salix gooddingii var. *vallicola* (Dudley) Ball
Tamarix gallica L.

SHRUBS

Acacia constricta Benth.
Acacia cuspidata Schlecht.
Acacia greggii Gray
Acacia wrightii Benth.
Agave lechuguilla Torr.
Aloysia ligustrina (Lag.) Small
Aloysia wrightii (Gray) Heller
Atriplex canescens (Pursh) Nutt.
Atriplex obovata Moq.
Baccharis glutinosa Pers.
Buddleia marrubifolia Benth.
Carlowrightia linearifolia (Torr.) Gray
Celtis pallida Torr.
Chilopsis linearis (Cav.) Sweet
Condalia lycioides (Gray) Web.
Condalia spathulata Gray
Croton fruticulosus Engelm.
Dasylirion leiophyllum Engelm.
Echinocactus horizonthalonius Lemaire
Echinocereus dasyacanthus Engelm.
Euphorbia antisyphilitica Zucc.
Fallugia paradoxa (Don) Endl.
Ferocactus hamatacanthus (Muhlenpf.) Britt. & Rose
Forestiera angustifolia Torr.
Fouquieria splendens Engelm.
Hymenoclea monogyra Torr. & Gray
Jatropha spathulata (Ort.) Muell. Arg.
Krameria parvifolia Benth.
Larrea tridentata (DC.) Cov.
Leucophyllum minus Gray
Lycium puberulum Gray
Mortonia scabrella Gray
Nolina erumpens (Torr.) Wats.
Opuntia leptocaulis DC.
Opuntia macrocentra Engelm.
Opuntia phaeacantha Engelm.
Parthenium incanum H.B.K.
Peniocereus greggii (Engelm.) Britt. & Rose
Phoradendron engelmanni Trel.
Phoradendron macrophyllum (Engelm.) Cockerell
Phoradendron tomentosum (DC). Engelm.
Porophyllum scoparium Gray
Prosopis juliflora (Swartz) DC.
Prosopis odorata Torr. & Frém.
Rhus microphylla Engelm.
Selloa glutinosa Spreng.
Sophora secundiflora Lag.
Tecoma stans (L.) H.B.K.
Ungnadia speciosa Endl.
Viguiera stenoloba Blake
Yucca carnerosana (Trel.) McKelvey
Yucca torreyi Shafer
Zexmenia brevifolia Gray

FORBS

Abutilon malacum Wats.
Abutilon wrightii Gray
Acleisanthes longiflora Gray
Actinea odorata (DC.) Kuntze
Allionia incarnata L.
Amaranthus graecizans L.
Amaranthus palmeri Wats.
Amaranthus torreyi (Gray) Benth.
Ammocodon chenopodioides (Gray) Standl.
Anemopsis californica (Nutt.) Hook. & Arn.
Anulocaulis reflexus Johnst.
Apodanthera undulata Gray
Aplopappus heterophyllus (Gray) Blake
Aplopappus spinulosus var. *turbinellus* (Rydb.) Blake
Asclepias longicornu Benth.
Aster leucelene Blake
Ayenia pussila L.
Bahia absinthifolia var. *dealbata* Gray
Bahia pedata Gray
Baileya multiradiata Harv. & Gray
Berula erecta (Huds.) Cov.
Boerhaavia intermedia Jones
Brickellia coulteri Gray
Brickellia laciniata Gray
Cassia bauhinioides Gray
Cassia lindheimeriana Scheeele
Cevallia sinuata Lag.
Chamaesaracha coronopus (Dunal) Gray
Chenopodium incanum (Wats.) Heller
Cleomella longipes Torr.
Coldenia canescens DC.
Commicarpus scandens (L.) Standl.
Convolvulus incanus Vahl
Cressa truxillensis H.B.K.
Croton corymbulosus Engelm.
Cyperus laevigatus L.
Cyphomeris gypsophiloides (Mart. & Gal.) Standl.
Datura meteloides DC.
Ditaxis neomexicana Muell. Arg.) Heller
Dyssodia aurea Nels.
Eleocharis marcotachys Britt.
Eriogonum abertianum Torr.
Eriogonum rotundifolium Benth.
Eriogonum tenellum Torr.

Eucnide bartonioides Zucc.
Euphorbia albomarginata Torr. & Gray
Euphorbia arizonica Engelm.
Euphorbia revoluta Engelm.
Eustoma russellianum (Hook.) Griseb.
Evolvulus alsinoides L.
Froelichia arizonica Thornber
Galium wrightii Gray
Gutierrezia microcephala (DC.) Gray
Heliotropium curassavicum L.
Hoffmanseggia densiflora Benth.
Houstonia angustifolia Michx.
Iva ambrosaefolia Gray
Janusia gracilis Gray
Laphamia rupestris Gray
Lappula redowski (Hornem.) Greene
Lepidium montanum var. *angustifolium* Hitchc.
Lesquerella purpurea (Gray) Wats.
Macrosiphonia macrosiphon (Torr.) Heller
Nama havardii Gray
Nicotiana trigonophylla Dunal
Oenothera brachyptera var. *wrightii* (Gray) Levl.
Oligomeris linifolia (Vahl) Macbr.
Orobanche ludoviciana Nutt.
Parosela lachnostachys (Gray) Heller
Parosela pogonathera (Gray) Vail
Parosela wrightii (Gray) Vail
Pectis angustifolia Torr.
Pectis filipes Harv. & Gray
Perezia wrightii Gray
Peritvle parryi Gray
Petunia parviflora Juss.
Phacelia integrifolia var. *robusta* Macbr.
Phaseolus wrightii Gray
Pluchea sericea (Nutt.) Cov.
Polygala obscura Benth.
Psathyrothes scaposa Gray
Rivina humilis L.
Sarcostemma torreyi (Gray) Woods
Selinocarpus parvifolius (Torr.) Standl.
Sida hederacea (Dougl.) Torr.
Sida procumbens Swartz
Solanum elaeagnifolium Cav.
Sphaeralcea angustifolia var. *cuspidata* Gray
Suaeda suffrutescens Wats.
Tetraclea coulteri Gray
Tidestromia lanuginosa (Nutt.) Standl.
Trianthema portulacastrum L.
Trixis californica Kell.
Typha angustifolia L.
Vernonia marginata (Torr.) Raf.
Viguiera longifolia (Rob. & Greenm.) Blake

GRASSES

Aristida adscensionis L.
Aristida glauca (Nees) Walp.
Aristida orcuttiana Vasey
Aristida ternipes Cav.
Bouteloua aristidoides (H.B.K.) Griseb.
Bouteloua barbata Lag.
Bouteloua breviseta Vasey
Bouteloua curtipendula (Michx.) Torr.
Bouteloua eriopoda Torr.
Cathestecum erectum Vasey & Hack.
Cottea pappophoroides Kunth
Cynodon dactylon (L.) Pers.
Distichlis stricta (Torr.) Rydb.
Eragrostis arida Hitchc.
Heteropogon contortus (L.) Beauv.
Hilaria mutica (Buckl.) Benth.
Muhlenbergia porteri Scribn.
Panicum arizonicum Scribn. & Merr.
Panicum hallii Vasey
Panicum hirticaule Presl.
Pappophorum wrightii Wats.
Setaria macrostachys H.B.K.
Sporobolus airoides Torr.
Sporobolus pyramidatus (Lam.) Hitchc.
Trichloris mendocina (Phil.) Kurtz
Triodia albescens Vasey
Triodia pulchella H.B.K.

Summary

Sierra Tierra Vieja, in western Presidio and Jeff Davis Counties of Trans-Pecos Texas, is a range paralleling the Rio Grande. It resulted from a lava flow of early Tertiary time, deformational movements of mid-Tertiary time, and consequent erosion. The topography is largely due to numerous faults and deeply eroded canyons.

Few botanists have visited the range and no previous intensive study of it has been made.

The records of the weather stations along the eastern foot of the range, indicate an average annual rainfall of about fifteen inches. The average along the summit almost fifteen hundred feet higher in elevation, is probably eighteen to twenty inches. Rainfall, and not length of time between killing freezes, is the limiting factor in plant growth.

Topography and varying rainfall result in contrasting regions of vegetation. The eastern slope of the cuestas supports mostly grasses, a thin oak forest appearing on the north slopes of the higher points. At lower elevations on the eastern side of the range desert shrub vegetation appears in spots where the exposure is greatest.

Because of the running water and less exposure the canyons on the eastern side have vigorous trees and some variety of other ligneous vegetation. At one locality a pinon-juniper association, consisting of Mexican pinon and alligator juniper, is found.

The vegetation of the western side of the range consists largely of desert shrub, cacti, creosote bush, mesquite, cat's-claw, and ocotillo being the characteristic species.

REFERENCES

BAKER, C. L. 1927—Exploratory geology of a part of southwestern Trans-Pecos. Univ. Tex. Bull. **2745**.

———1935—Major structural features of Trans-Pecos Texas. Univ. Tex. Bull. **3401**: 137-214.

COTTLE, H. J. 1932—Vegetation on north and south slopes of mountains in southwestern Texas. Ecology **12**:121-134.

EMORY, W. H. 1857-59—Report of the United States and Mexican Boundary Survey **1**:85-92; **2**: Part II.

HINCKLEY, L. C. 1944—The vegetation of the Mount Livermore area in Texas. Amer. Mid. Nat. **32**:236-250.

NEALLEY, G. C. 1888—Report of an investigation of the forage plants of western Texas. U. S. Dept. Agr. Bot. Div. Bull. **6**.

WOOTON, E. O. 1906—Southwestern localities visited by Charles Wright. Bull. Torr. Bot. Club **33**:561-566.

YOUNG, M. S. 1914—Notes on botanical collections in western Texas. Unpublished data. Bot. Dept. Univ. Tex.

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A Synoptic Key to the Salientian Eggs of the United States

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Introduction

Data for the present paper were gleaned from the examination of what preserved material has been available, almost entirely in the museum of Cornell University, a few specimens of fresh egg masses that the writers have been able to collect, and primarily, from the literature of previous authors. In the past only scattered notes on the eggs of the Salientians of this country were published and to date no comprehensive work has been done along this line. It is hoped that such an organization of information as is here presented will be of some use to other workers in the field. Furthermore, by pointing out a few of the difficulties, discrepancies, and lack of information regarding the eggs and egg laying habits of frogs and toads of the United States, it is hoped that others may find it worth their while to attempt to correct the existing state of affairs.

No complete key to the eggs of the tailless amphibians of this country has so far been prepared. Wright and Wright (1924) published the only key of any extent when they brought forth *A Key to the Eggs of the Salientia East of the Mississippi River*. This same key was reprinted in Wright's, *Life Histories of the Frogs of Okefinokee Swamp, Georgia* (1931). Previous to this, Wright (1914) presented a key to the eggs found in the region of Ithaca, New York in his, *Life-histories of the Anura of Ithaca, New York*. Other keys covered restricted areas and included the eggs of both the Caudata and Salientia (Storer, 1925; Smith, 1934).

At this point the writers wish to acknowledge the courtesies extended them by various individuals during the preparation of this key. Dr. T. I. Storer made available specimens of *Bufo boreas halophilus, Rana aurora draytonii, R. boylii boylii* and *R. boylii sierrae* for examination. Miss B. L. Matalas kindly lent the few specimens from the collection of the American Museum of Natural History, of which *Pseudacris nigrita triseriata* was used for one of the microphotographs appearing in the plates.

Egg Habits of World Salientians

Before examining in any detail the eggs and egg-laying habits of the frogs and toads of the United States, it might be advisable first to consider briefly the habits pertaining to the forms of the world. Concepts based entirely on our North American species would lead us to believe that this phase of the life history is quite uniform. This, however, is far from the actual situation obtaining in this group of animals the world over. Salientians have adopted rather uniform breeding habits in the north temperate regions, but in the tropics and sub-tropics there are extant examples of the greatest diversity. Therefore, in order better to understand the habits of our forms, a short survey of all forms is presented here. The utilization of the numerous situations and methods of caring for the reproductive elements among the Salientia impresses on us very strongly the remarkable adaptiveness of these lowly vertebrates. Such diversity exists in no other group of vertebrates.

The following outline of the egg habits noted in various parts of the world is an attempt to put into condensed form the major aspects of these widely varying conditions. A discussion by families was first considered, but since no definite widely accepted classification is available and since there would be much overlapping in "types" of egg laying, it seemed that this shorter method might suffice just as well. Such an outline most likely has many shortcomings; one might be the all inclusiveness of some of the subdivisions, but this is no place for splitting hairs. The animals' individual variation gives rise to enough confusion along these lines.

Scientific names and terms of extra-United States forms in the following discussion are those used by the various authors from which the data were taken. There has been no attempt at organizing such names into any standard nomenclature. Names concerning forms from this country are those given in the last check list (1943) by Stejneger and Barbour.

I. Eggs deposited in truly aquatic situations.
  A. Parent prepares a mud-walled basin in ponds.
  B. Parent makes no preparation nor takes subsequent care.
    1. Eggs deposited singly.
    2. Eggs deposited in clusters.
      a. Strings.
        (1) On bottom.
        (2) At or near the surface.
      b. Elongate bands or cylinders.
      c. Floating masses.
        (1) Films.
        (2) Frothy masses.
        (3) Clumps.
      d. Non-floating globular or irregular grape-like clumps.
        (1) Unattached.
        (2) Attached.

II. Eggs deposited in terrestrial situations.
  A. On the ground.
    1. In rocky places.
      a. On rocks overhanging water.
      b. In rock crevices.

2. In cavities or burrows.
   a. Cavities under grass near bodies of water; eggs washed into water by rains.
   b. Simple burrows.
      (1) Under rocks and stumps.
      (2) In open.
   c. Burrows connected to water by a tunnel.

B. On vegetation.
   1. Leaves or other material on the ground.
   2. Ground plants.
   3. Trees, shrubs and climbing vines.
      a. Developing egg mass drops into water or onto moist ground.
      b. Complete development on the plant.

III. Eggs carried on or within the body of adults.

A. On the back.
   1. Loosely adhering to back and/or limbs.
   2. Raised fold of skin holding mass.
   3. Skin forming a pouch that covers the mass.
   4. Individual pockets for the eggs.

B. On the belly.

C. In the mouth.

D. Within the vocal sacs of the male.

E. Within the uterus (*Ovoviviparous*).

Aquatic situations.—Most Salientians use bodies of water as the medium in which to lay their eggs. In such cases there are usually no preparations made for the eggs nor any subsequent care taken to further insure the survival of the offspring. However, *Hyla faber* and *Leptodactylus ocellatus,* both found in Brazil, construct ringed-basins of mud within the confines of ponds. Care is taken to smooth the inner wall of these basins which are about a foot in diameter and just a few inches above the water level. Eggs are deposited in these chambers and there develop until rains and rising water liberate the young animals.

When deposited singly, it is the usual habit to attach the ova in the water to objects such as twigs, leaves, stems of grass or rocks. This varies with the different species and often with the individual. Also, those frogs which normally lay individual eggs may at times emit two to several. This is true with *Kassina senegalensis* of Africa, *Xenopus laevis* of Africa, which attaches its eggs to stones or water plants, and the European genera *Discoglossus* and *Bombinator.* These last two may attach their eggs to weeds or merely allow them to sink to the bottom of the pond. Among the ranids we find that *Rana grayi* of South Africa (Rose, 1929) deposits eggs singly. In this country are a number of frogs and toads that lay single eggs, namely *Bufo punctatus,* which is the only *Bufo* that does this, *Acris gryllus, Pseudacris ocularis, Hyla andersonii, H. arenicolor, H. crucifer, H. gratiosa* and *H. squirella.*

The greater majority of frogs and toads which deposit their eggs in water lay the reproductive elements in some sort of a mass or cluster which is more often than not attached to water plants or debris in the area chosen. As noted in the preceding outline these masses may be in the form of strings, bands or cylinders, floating films and masses or attached grape-like or globose bunches. Number of eggs per cluster is extremely variable for the different genera and

species. In Europe the range seems to be from about 29 (*Alytes obstetricans*) to 12,000 (*Bufo viridis*) eggs in the mass (Boulenger, 1896-97). In this country the extremes are even greater, 5-30 (*Hyla c. cinera*) to 25,650 (*Bufo w. woodhousii*). In other parts of the world the numbers seem to fall within these extremes.

All species of *Bufo*, except *Bufo punctatus*, have the eggs in strings. These long strings, with one to three or four ova in the width, are usually wound among debris or water plants and may or may not be in direct contact with the bottom of the ponds. In the South Pacific there are some genera of the family *Bufonidae* (*Bufo, Pseudobufo, Pedostibes* and *Pelophryne*) that lay their strings attached to the surface vegetation rather than submerged (Loveridge, 1945).

Masses in the form of bands or cylinders are found deposited by the European genera *Pelodytes* and *Pelobates* (Boulenger, 1896-97; Gadow, 1923) which wrap them around and between the stems of water plants. *Scaphiopus* of this country is quite similar in respect to the mass of eggs laid and method of attachment.

Some of the American frogs have the habit of depositing floating films of eggs; these may be very small, as with *Hypopachus* and *Microhyla*, with dimensions of one by one inch to four by seven inches, or they may be quite extensive, as with *Rana clamitans, R. grylio* and *R. catesbeiana*. The latter may deposit a film as much as three by five feet in area containing as many as 20,000 eggs. A peculiar habit of some of the tropic and sub-tropic frogs is to lay a frothy mass of eggs which floats on the water's surface. Such a condition has been recorded for *Hyla caerulea, H. aurea* and the genus *Limnodynastes* of Australia and New Guinea. It has also been noted for *Paludicola fuscomaculata* (Noble, 1927) and *P. biligonigera* of Brazil, and *Phryniscus nigricans* of Paraguay. Whether these frothy masses are actually deposited on the water's surface in this form or whether they are deposited on land near water and are washed into it by rains is still questionable. *Rana temporaria* of Europe lays a clump of eggs containing 1,100 to 4,000 ova, which at first sinks to the bottom but after swelling, rises to the surface to form a large floating globular mass.

Of the numerous Salientia that spawn in water, examples are found in all families that deposit non-floating clumps. Practically all of these attach the masses to water plants, debris or rocks, either near the bottom or ranging up to a point where the uppermost portion of the cluster is at the water's surface. *Hyla arborea, Rana arvalis* and *R. esculenta*, all of Europe, are three examples of animals that do not follow the above rule, but lay eggs that remain unattached on the bottom of ponds.

Terrestrial situations.—Many are the frogs and toads that have taken to the diverse niches on land for the deposition of their eggs. As previously mentioned, the majority employing such methods are found in the tropics and subtropics.

Although it is normal for forms that deposit their eggs on objects over-

hanging water to utilize vegetation, sometimes they may even use overhanging rocks or small cliffs. One such example is *Natalabatrachus bonebergii* of Natal; this species attaches clusters to exposed rocks two to six feet above the surface of the water. Other examples which may do so are *Chiromantis rufescens* (Noble, 1924), *Phyllomedusa iheringi* and *burmeisteri, Hyla nebulosa* and *Rhacophorus maculatus* (Brandes and Schoenichen, 1901).

A few frogs prefer moist crevices among rocks as the place in which to lay eggs. *Rana opisthodon* of the Solomon Islands (Boulenger, 1920) lays eggs which are 6 to 10 mm. in diameter in crevices close to water. Our *Eleutherodactylus latrans* of Texas chooses crevices in cliffs and ledges. Neither of these forms makes a frothy mass of the cluster. The genus *Cycloramphus* also deposits its eggs out of water among rocks (Noble, 1931).

Pseudophryne australis and *bibroni* make use of little cavities under grass and reed tussocks and stones on the edge of pools, into which the developing eggs are washed by rains and rising water. *Leptodactylus labialis* of this country likewise deposits its frothy cluster of eggs in small excavations near water at the base of grass hummocks.

There are several forms that prepare rather simple burrows for their eggs. These may be under rocks, stumps or other similar objects, or they may be more or less in the open. Development may or may not go to completion within the burrow. One species, *Leptodactylus mystacinus* of Brazil, lays straw-colored eggs in a covered-over cavity the size of a tea-cup, dug under stones or rotten tree trunks, always in the neighborhood of ponds and just high enough above the water so that during the rainy season the nest will be inundated. The eggs are enveloped in a foamy, sticky mass in which the tadpoles live until set free by rains. Nieden (1923) writes of similar situations concerning *Hylodes* and *Crinia. Hylodes luteolus* and *H. martinicensis* lay their egg masses in holes in moist earth, the masses covered with a slime. Complete deveolpment takes place within the mass. With *Crinia laevis* of Tasmania the adult not only digs a chamber, but goes to the added effort of polishing the walls. Here also there is no metamorphosis. According to Noble (1931) the genus *Arthroleptis* also prepares shallow burrows on land. *Anhydrophryne rattrayi* and *Breviceps gibbosus* of Africa lay about twenty eggs which complete the development in the chamber (Rose, 1929) as do *Liopelma hochstetteri* and *L. hamiltoni* of North Island and Stephen Island in the South Pacific (Loveridge, 1945).

A curious habit of certain Salientians is to excavate a nest chamber and then connect the cavity to water or its immediate proximity by a tunnel. *Hemisus* sp. of Africa makes its nest under the surface of a bank, deposits the eggs, then remains in the neighborhood to look after her brood until hatched. At this time she digs a tunnel from the nest to the water through which the young make their way. Schlegel's Tree-Frog, *Rhacophorus schlegeli,* of Japan, digs a cavity in a mound or muddy bank of ponds, paddy fields and so forth. Within this cavity, which is four to five by six inches, the yellow eggs in a gelatinous fluid are laid. This is then trampled until a foamy mass

two by four inches is produced, after which both the male and female proceed to burrow a tunnel down to the water. Tadpoles hatch out in about five days but live on the albuminous mass for another three to four days before traveling along the tunnel to the water.

Among the Salientians that have deposition in terrestrial situations, there have been considerably more records of the use of vegetation rather than burrows or rocky places. Some of these keep relatively near the ground. However most apparently prefer to get some distance above the surface into bushes, vines and trees. *Engystoma ovale* puts its eggs on debris between fallen trunks where rainwater will keep them moist (Brandes and Schoenichen, 1901). The Chirping Frog, *Arthroleptella lightfooti*, of Africa, deposits small clusters of large (Vit. 4.5; envelop 8.0 mm.), unpigmented eggs on damp moss, where the complete metamorphosis takes place (Rose, 1929). Ahl (1931) notes three species of *Rhacophorus* that prefer the ground vegetation usually at the edge of small puddles; *R. leucomystax* of India, Malaya, the Philippines and South China lays its small, unpigmented eggs on leaves and other objects at the edge of small ponds, as does *R. lincki* of the Philippines. In Cuba, *Sminthillus limbatus* lays single eggs on leaves on the ground and *Nyctimantis* (*Hyla*?) *uranochroa* also lays its eggs on ground leaves from which the tadpoles make their way to the water. The Robust Frog, *Asterophrys robusta*, makes use of rotten stumps in its breeding habits by depositing in such places about seventeen eggs which are guarded by the male. *Eleutherodactylus ricordii* of Florida deposits twelve to twenty-five eggs in vegetable debris and leaf mold in depressions in woods.

On Mt. Murud, Borneo, Mjöberg's Frog, *Philautus mjöbergi*, lays its eggs in the pitcher portion of pitcher plants, while Hazel's Frog, *Philautus hazelae*, of the Philippines, deposits the eggs in the axillae of the abaca plant. The West Indian Islands species *Hylodes martinicensis* in May and June lays twenty to twenty-five straw-colored eggs in a foamy mass in the axillae of Iridaceous plants.

In those species which attach their ova to trees, shrubs and vines, development may go to completion with the young never leaving the plant on which they were deposited until they become fully metamorphosed, or the mass may drop off the plant at some time antecedent to completion of metamorphosis. In the latter case the egg mass is most often fastened to leaves or twigs overhanging bodies of water or moist ground. Such nests are formed by gluing several leaves together with the frothy jelly of the egg cluster. Examples of forms employing this habit are *Chiromantis petersi* of East Africa, *C. xerampelina* of Africa, *C. rufescens* of West Africa, *Phyllomedusa hypochondrialis* and *P. iheringi* of South America, *Rhacophorus horridus* of Malayan Islands, *R. leucomystax* of Malacca, *R. malabaricus* of Malabar, *R. reinwardtii* of Java, *R. reticulatus* of Ceylon and *R. vittatus* of Burma, Siam and China.

Not nearly as consistent as the above are the forms whose eggs go to complete development on the vegetation. *Hyla nebulosa*, however, does make a similar nest by gluing its eggs to withered leaves or to the inner side of banana

leaves, but this mass does not drop off the tree before development of the eggs is complete. The axillae of the Nipa palm (*Nipa fruticans*) are utilized by the Nicobar Frog, *Rana nicobariensis*, of Batavia, and the tubers of climbing plants are used by the Yellow Frog, *Oreophryne flava*, of New Guinea, which deposits strings of ten to twenty eggs on them. The genus *Hoplophryne* lays its eggs between the leaves of banana trees or in old bamboo stems. *Hylodes* (*Eleutherodactylus?*) *auriculatus*, of Cuba, Haiti and Porto Rico, lays twenty to thirty fairly large, 4.5 to 5.5 mm., eggs attached to leaves of trees. The young leave the eggs well developed, with only a tail stump present. The parent of *Hyperolius obstetricans* of Cameron stays with its eggs until they are developed. About thirty-nine eggs are fastened to the surface of a leaf. *Hyla resinifictrix* of the Amazon deposits its eggs in holes in treees, these holes filling up with rain water. Likewise *Rhacophorus moloch* of Africa puts its eggs in water-filled cavities in tree trunks. This is true also of *Rhacophorus spinosus* of Mindanao. Eaton (1941) tells of a frog of Panama, *Dendrobates auratus*, the male of which carries the developing larvae from place of deposition to water-filled cavities in the tree trunks, a single cavity being used by several adults. Females of this species contained only one to four ova in each ovary.

Eggs on or within the body of adults.—Some Salientians have become quite specialized in their methods of depositing and caring for the reproductive elements by carrying them about on or within their own bodies. These conditions range from simply attaching the eggs loosely to the parts of the body by mucous secretions to the development of brood pouches, and, in the extreme, maintaining the developing ova within the uterus. The well-known European forms of *Alytes* deposit the rosary-like strings of eggs on land and the male thrusts his hind legs through the mass and works it up onto the posterior part of the back and the proximal portion of the hind legs. In this manner the eggs are cared for until time of hatching, when the male carries the mass to a pond to liberate the young. The Brazilian *Hyla ohausi* carries the egg mass heaped up on the back of the female and attached only by a secretion from the skin. The male of *Hylophorbus robustus* of New Guinea fastens the eggs to his arms and cares for them until hatched, complete metamorphosis taking place within the eggs.

A slightly more secure habit of caring for the eggs is by the formation of a partial fold of skin which holds the mass in place. In the family *Hylidae* this is not an uncommon situation, for the genus *Hemiphractinae* has evolved such a condition in the female. Similarly the female of *Hyla goeldii* of Brazil holds her mass, containing about twenty-five eggs which are four millimeters in diameter, on the back by a partially raised fold of skin.

Still further advanced are those species that have developed a complete pouch by a growth of skin on the back of the females. This situation prevails in several of the *Nototrema* (*Gastrotheca*) of South America. *N. marsupiatum* of Ecuador and Peru carries about two hundred eggs in her brood sac, but only through part of the development. *N. testudineum* of Ecuador and Peru, *N. oviferum* of Venezuela, Costa Rica and Mexico, and *N. fissipes* of Pernambuco carry a decidedly lesser number of eggs (15±) in their pouches,

but carry them to complete development. With all of these forms the pouch opens backward just in front of the vent; it has a sphincter and is permanent. Another *Nototrema* having a complete pouch is *N. pygmaeum* of Venezuela, but here only four to seven eggs are carried and the pouch opens by a longitudinal slit. Fully formed young emerge from the dorsal pouch of the genus *Amphignathodon*.

A modification of the brood pouch is found in the South American *Pipa*. Here each egg is in its own individual chamber, covered by a lid, on the back of the female. Complete metamorphosis takes place within these chambers.

In Africa there is a form, *Hemisus marmoratum*, that has the pouch forming on the under surface of the female. After laying the eggs, the adult covers them with her body and the sac forms around the mass. The larvae slip out of this chamber as well-developed tadpoles. *Rhacophorus reticulatus* of Ceylon presses the small eggs into her covered belly pouch; about twenty ova are carried in this manner.

In West Africa there is a tree-frog, *Hylambates breviceps*, which deposits a few large eggs (4.0 mm. diameter); these eggs are carried about in the mouth of the female (Cunningham, 1912).

An even more peculiar habit of caring for the offspring is that of *Rhinoderma darwinii*. The male of this species puts the eggs into his vocal sacs and there they remain until they are fully formed froglets.

The highest development in caring for the eggs seems to be that of the East African genus *Nectophrynoides*. Members of this group maintain the eggs within the uterus and give birth to fully formed young. Within a single uterus of *N. vivipara* there may be over one hundred larvae (Noble, 1931).

Introduction to the Key

Even though all but one of the Eleutherodactylids that occur in the United States are included in the key, this group is still only vaguely known. If it were not for the peculiarity in the manner of deposition and appearance of the eggs, as compared with the other Salientia of this country, our present knowledge would not enable us to present them in any key.

Much in the way of adequate field descriptions is lacking in the study of the eggs of frogs and toads in this country. Seldom are there complete notes published on the appearance of the masses in the field. It is surprising to find that that phase of the life history receives no more attention than it does at present, nor has in the past, with herpetologists. Some of the field data that would aid greatly in the future study of this subject are suggested as follows: location, date, place of deposition (margins or centers of ponds), appearance of mass (globular, plinth, irregular, etc.), how attached and to what, depth of mass, depth of water, type of pond or stream (stagnant, fresh, slowflowing, swift, clear, muddy, rocky, sandy bottom), vegetation in the water and on the bank, air temperature, water temperature, other amphibians or their eggs, state of development at time of collection, and pigmentation. Data that could be completed at a somewhat later time in the laboratory are: volume of mass,

volume of individual eggs, number of eggs per mass, complement per frog, number of envelopes, diameter of vitellus, vitelline capsule, and all subsequent gelatinous envelopes.

Another failure in the study of eggs of Salientia of this country is the laxness in collecting specimens from various localities throughout an animal's range. A much clearer concept of the optimum appearance and condition of deposition could be gained by further collecting. After a description appears in print, most workers seem satisfied to take that description without additional investigation. Hence, sooner or later a difficulty arises, as in the case of *Pseudacris nigrita triseriata,* where two almost totally different descriptions are given for the one form. Such as this may also arise by failure to use care in the collecting, preserving, and identification of the eggs. A sampling over wide areas may very possibly give further data relevant to the geographical variation of these animals and shed some light on the validity of some of the species and subspecies that have been considered by the taxonomists.

So far as this writer has been able to determine, by questionnaire, there are at present no collections of Salientian eggs of any size or completeness in existence in this country. Even the commonest forms have not been kept to provide a reference for future use. The only depository of any size is at Cornell University, and, sorry to say, that collection has been harmed in recent years by breakage of a steam line in the place of storage and through the addition of alcohol to several specimens in the process of replenishing the preservative. In other words, this aspect of the study is practically nil.

Perhaps the best method of preserving amphibian eggs is first to put them in ten per cent formalin for not more than twenty-four hours. After this time has elapsed, they should be removed to a four per cent solution of formalin for permanent storage. The use of alcohol is decidedly detrimental to the muco-protein forming the jelly envelopes and will dissolve it away in a short time. When collecting both the eggs and the adults of these animals, it is often the habit to attempt to preserve both in the same container, and as a result the eggs are soon rendered valueless by the alcohol most often used for the preservation of the mature animals.

The only sure method of identifying many of the eggs is to observe the female in the act of laying, and then collect both the adult and the eggs. In this event it should be remembered that the jelly of the eggs may take some time before it swells to normal size, fifteen minutes to twelve hours or more, and should be allowed to do so before being put into any preservative. Eggs laid in the laboratory often are not of normal appearance for usually they are deposited in glass containers without provision for attachment; and even if this is done many specimens will not deposit normally in the abnormal situation. Such masses will become flattened by the bottom and walls of the container and will fail to gain the natural shape and size.

Along this line it might be well to point out that in collecting eggs, caution must be used not to overcrowd specimens of eggs or pack them with animals and other materials. Putting masses in cheese cloth is not recommended for the

jelly will adhere to the cloth and in unpacking the specimens will be damaged and distorted. The best method is to be provided with proper sized jars or tins, even though this may be bulky and at times cumbersome. In storing a collection, it is expedient not to place it in excessive heat or in sunlight, otherwise the jelly will deteriorate rapidly.

Of the ninety-six forms of Salientia described from this country, sixty-four are embodied in the synoptic key, the remaining thirty-two are either totally undescribed or insufficiently so as to warrant their incorporation into the present work. The thirty-two forms not found in the following key are:

1. *Eleutherodactylus augusti* (Duges).
2. *Scaphiopus hammondii intermontanus* (Cope).
3. *Scaphiopus holbrookii albus* (Garman).
4. *Bufo americanus copei* Yarrow and Henshaw.
5. *Bufo boreas nelsoni* Stejneger.
6. *Bufo canorus* Camp.
7. *Bufo debilis* Girard.
8. *Bufo exsul* Myers.
9. *Bufo hemiophrys* Cope.
10. *Bufo insidior* Girard.
11. *Bufo marinus* (Linné).
12. *Acris gryllus crepitans* Baird.
13. *Pseudacris brimleyi* Brandt and Walker.
14. *Pseudacris nigrita nigrita* (LaConte).
15. *Pseudacris occidentalis* (Baird and Girard).
16. *Hyla avivoca* Viocca.
17. *Hyla baudinii* (Dumeril and Bibron).
18. *Hyla cinerea evittata* (Miller).
19. *Hyla septentrionalis* Boulenger.
20. *Hyla versicolor chrysoscelis* (Cope).
21. *Hyla versicolor phaeocrypta* (Cope).
22. *Hyla wrightorum* Taylor.
23. *Rana areolata areolata* Baird and Girard.
24. *Rana boylii muscosa* Camp.
25. *Rana fisheri* Stejneger.
26. *Rana heckscheri* Wright.
27. *Rana onca* Cope.
28. *Rana pipiens berlandieri* (Baird).
29. *Rana pipiens brachycephala* (Cope).
30. *Rana sylvatica latiremis* (Cope).
31. *Rana tarahumarae* Boulenger.
32. *Microhyla carolinonsis mazatlanensis* Taylor.

Key to the Salientian Eggs

1. Eggs deposited in terrestrial situations.
   2. Egg cluster a frothy mass; number of eggs large (80±). Gelatinous envelopes lacking; vitellus 1.5 mm. in diameter, of light yellow color. Usually deposited in small excavations near water at base of grass hummocks, etc. Range, Mexico to extreme southern Texas in Starr and Hidalgo counties. Season, first half of June ..... *Leptodactylus labialis.*
   2. Egg cluster not a frothy mass; number of eggs small (6-25).
      3. Vitellus large (6.0-7.5 mm.), egg deposited in moist or rain-filled cracks or crevices in rocky cliffs and ledges. Range, Texas, Helotes and Waco. Season, February to May ..... *Eleutherodactylus latrans.*
      3. Vitellus small (2.0-4.0 mm.); not pigmented.
         4. Florida Peninsula as far north as Jacksonville. Vitellus 2.0 mm.; outer gelatinous envelope reaches 4.0 mm.; eggs numbering 12-25. Deposited in vegetable debris and leaf mold in depressions in woods, etc. Season, April to August ..... *Eleutherodactylus ricordii.*
         4. Texas.
            5. Lower Rio Grande Valley, Brownsville. Ovarian evidence; vitellus 3.0 mm., seldom 3.5 mm. Eggs in clutch numbering 6-7. Season, April to May ..... *Syrrhophus campi.*
            5. San Antonio, San Marcos and Austin to Chisos Mts. Ovarian evidence; vitellus 4.0 mm.; complement 6-10 eggs ..... *Syrrhophus marnockii.*

1. Eggs deposited in truly aquatic situations.
   2. Eggs deposited singly.
      3. Two gelatinous envelopes.
         4. Outer envelope more than 3.0 mm. in diameter (3.5-4.0 mm.). Inner envelope 1.9-2.0 mm.; vitellus 1.2-1.4 mm. Eggs deposited on or near bottom of slow-moving streams, non-stagnant pools, etc.; attached to sphagnum or free. Complement per female 800-1,000. Eggs dark brown above and creamy white below. Range, central New Jersey to South Carolina. Season, first of May to near end of July ..... *Hyla andersonii.*
         4. Outer envelope 2.0 mm. or less in diameter (1.4-2.0 mm.). Inner envelope 1.2-1.6 mm.; vitellus 0.8-1.0 mm. Eggs deposited on bottom of shallow pools of practically any ecological type; complement 950. Eggs brown above and white to cream below. Range, Virginia to Florida, west to Texas and northward up the Mississippi river to Indiana. Season, April to August ..... *Hyla squirella.*
      3. One gelatinous envelope.
         4. Envelope 2.0 mm. or less in diameter (1.2-2.0 mm.).
            5. Vitellus 0.6-0.8 mm. Eggs deposited in shallow water on the bottom; complement 100; brown above and cream below. Range, North Carolina to southern Florida. Season extensive, every month of the year in Florida; January to September elsewhere ..... *Pseudacris ocularis.*
            5. Vitellus 0.9-1.1 mm. Eggs deposited in shallow water near bottom among grass or other plants in matted vegetation; complement 750-1,000. Eggs black or brown above and cream or white below. Range, Gaspé Peninsula to Manitoba and Minnesota, south to northeastern Kansas, Arkansas, Louisiana, Texas, Mississippi, Alabama, Piedmont, Georgia, South Carolina to New Brunswick. Season, first of January to June ..... *Hyla crucifer.*
         4. Envelope 2.3 mm. or more in diameter.
            5. Vitelline membrane far from vitellus, giving appearance of a second envelope. Outer envelope 2.3-5.0 mm. in diameter; loose and irregular in outline. Vitelline membrane 1.6-2.5 mm. Vitellus 1.0-1.8 mm.; greenish brown above and yellowish below. Eggs deposited on bottom of ponds; complement 2,084. Range, North Carolina to Florida, west to Tennessee, Alabama, Mississippi and Louisiana. Season, March to August ..... *Hyla gratiosa.*
            5. Vitelline membrane close to vitellus, not giving appearance of second envelope.
               6. Vitellus 1.8-2.4 mm., average 2.07 mm. Envelope 3.87-5.0 mm., average 4.40 mm. Eggs usually attached to leaves, sticks, debris and rocks on or near the bottom; may sometimes be floating and in small potholes eggs may be clumped. Several hundred in the complement. Range, western Texas through extreme southern Colorado, Utah to Colorado River of Nevada, down it to lower California and up southern California coast to Ventura county. In Mexico to Guadalajara, Guadalajaca and Toluca. Season, first of March to July. ..... *Hyla arenicolor.*
               6. Vitellus 1.3 mm. or less (0.9-1.3 mm.).
                  7. East of the Mississippi River. Vitellus 0.9-1.0 mm. in diameter; brown above and white below. Envelope 2.4-3.6 mm.; firm and definite in outline. Eggs deposited in shallow water strewn on the bottom or attached to stems of grass or other vegetation. Complement 250. Range, Dismal Swamp, Virginia south to Florida and west to the Florida parishes of Louisiana. Season, extensive, any

month of the year in Florida; February to October elsewhere .... *Acris gryllus gryllus.*

7. West of the Mississippi River. Vitellus 1.0-1.3 mm.; black above and white below. Envelope 3.2-3.6 mm. Eggs stuck to bottom of streams, pools, etc.; may appear as short files or sometimes as a loose bottom film. Range, Arkansas, Kansas, Colorado, Utah, western Texas, Arizona, southeastern California, and lower California; a form of desert canyons and rock bound pools and streams. Season, April to June ..... *Bufo punctatus.*

2. Eggs deposited in masses.

3. Mass a surface film.

4. Size of film large; 35 square inches (5″ × 7″) or larger.

5. One gelatinous envelope; 6.4-10.4 mm., average 7.6 mm.; loose and merges into the mass. Vitellus 1.2-1.7 mm., average 1.3 mm.; black above and white or cream below. Mass 144-675 square inches (2.5′ × 0.5′ × 3′ × 5′), in form of a disc; 10,000 to 20,000 eggs per complement. Deposited among water plants or brush. Range, Canada to Mexico east of the Rockies, not in southern half of Florida; introduced into western United States. Season, February to July ..... *Rana catesbeiana.*

5. Two gelatinous envelopes.

6. Mass less than one square foot in extent (5″-″7 × 12″). Usually deposited around margins of permanent ponds; either attached to vegetation or free. 1,000 to 5,000 eggs per mass, in single layer sharply outlined on surface. Vitellus 1.2-1.8 mm., average 1.5 mm.; black above and white below. Vitelline capsule may be rather remote from vitellus. Inner envelope 2.8-4.0 mm., average 3.3 mm.; circular, elliptical, or pyriform; always distinct. Outer envelope 5.0-6.0 mm., average 5.7 mm.; indistinct, merges into the jelly film. Range, southeastern Texas to Louisiana, Arkansas, southeastern Oklahoma, eastern Kansas through Iowa, western Minnesota to Canada, east to Gaspé Peninsula. Not in southern half of Florida. Season, last of March to mid-August ..... *Rana clamitans.*

6. Mass over one square foot in extent (12″ × 12″ to 12″ × 25″). Usually deposited in mid-pond attached to vegetation. 8,000 to 15,000 eggs per complement. Vitellus 1.4-1.8 mm., average 1.6 mm.; black above and white below. Inner envelope 2.8-4.0 mm., average 3.45 mm.; distinct. Outer envelope 3.8-7.0 mm., usual range 4.0-6.0 mm.; indistinct, merges into jelly mass. Range, southern Louisiana to peninsular Florida, north to southeastern Georgia. Season, May through September; crest June and July ..... *Rana grylio.*

4. Size of film small; 28 square inches (4″ × 7″) or less.

5. Envelope a truncated sphere, flat above. Outline of envelope distinct and firm, giving the mass a mosaic appearance.

6. Envelope 2.8-4.0 mm., average 3.35 mm. Vitellus 1.0-1.2 mm., average 1.1 mm.; black above and white, yellowish or brownish below. Mass oblong, round or square; wide range in size, 1 × 1 to 4 × 7 inches or longer narrow film. 10 to 150 eggs per mass; 850 per female. Deposited in any depression containing water, temporary or permanent; not in deep pools. Range, Maryland to the Florida Keys, Gulf States to Texas, northward to southern Indiana, Kentucky, and northeastern Tennessee. Season, May to September..... *Microhyla carolinensis carolinensis.*

6. Envelope 1.5-2.0 mm. Vitellus 1.0 mm.; black above and white below. The rafts of eggs, loosely held together, float on the surface

of temporary pools. Complement of 700 eggs per female. Range, southern Texas to Forlon, Tamaulipas, Mexico. Season, March to October, in periods of heavy rains ..... *Hypopachus cuneus.*

5. Envelope not a truncated sphere. Outline of envelope not distinct and firm; not a mosaic.

6. Number of eggs per mass small, 5-40.

7. Inner envelope greater than 2.0 mm. (2.0-3.4 mm.), average 2.5 mm.; distinct. Eggs in mass 5-30; 340-500 per female. Vitellus 0.8-1.6 mm.; black or brown above and white to cream below. Outer envelope 3.2-5.0 mm.; poorly defined, merges into the jelly mass. Deposited not more than one inch below the surface; attached to floating vegetation. Range, Virginia to Florida along the coast, west to Texas, Oklahoma; up Mississippi River to southern Illinois and Missouri. Season, mid-April to mid-August ..... *Hyla cinerea cinerea.*

7. Inner envelope less than 2.0 mm. (1.4-2.0 mm.), average 1.7 mm.; distinct. Eggs in mass 5-40. 1,000-2,000 per female. Vitellus 1.1-1.2 mm.; brown or gray above and white to cream or yellow below. Outer envelope 4.0-8.0 mm., average 5.2 mm.; indistinct, ragged merging into the jelly mass. Masses laid 6-12 inches apart or sometimes less in shallow ponds, seldom over two feet deep. Attached loosely to vegetation or free; mass with numerous air bubbles. Range, Maine, southern Canada, west to Minnesota, South Dakota, south through Kansas and Oklahoma to the Gulf States and northern Florida. Season, end of April to mid-August ..... *Hyla versicolor versicolor.*

6. Number of eggs per mass greater, 100-200.

7. Outer envelope small, 2.8-3.0 mm.; indistinct. Vitellus 0.8-0.9 mm.; black or brown above and white below. May have an inner envelope close to vitellus. Mass oblong and irregular in outline. 645 eggs per female. Deposited in roadside ditches or large permanent ponds, attached to weed stems at surface of water, 4 to 8 inches in depth. Range, western Missouri and eastern Nebraska and Kansas through Oklahoma and central Texas to Mexico, west to Arizona and Sonora, Coahuila, Chihuahua, Sinola and Durango. Season, mid-March to September, in periods of heavy rain ..... *Microhyla carolinensis olivacea.*

7. Outer envelope large, 4.0-8.0 mm.; loose, indistinct and sticky. Vitellus 0.8-1.2 mm.; brown above and yellow below. Inner envelope 1.4-2.0 mm.; distinct. Mass circular, elliptical or otherwise; 0.5″ × 3-5″ to 4″ × 7″. 500-800 eggs per female. Deposited in grassy ditches, ponds, swamp prairies, attached to vegetation or floating debris; not more than ¼″-1″ below the surface. Range, coastal region of Virginia to Florida, to Louisiana; Texas possible but doubtful. Season, mid-April to September ..... *Hyla femoralis.*

3. Mass not a surface film. Submerged strings, cylinders or clusters.

4. Eggs not pigmented. Few eggs per mass (35-50) in rosary-like strings attached to under side of stones in cold, swift flowing mountain streams. Vitellus 4.0-5.0 mm. Single envelope 8.0 mm. Range, British Columbia south to northern California, east to Montana. Season, May to September ..... *Ascaphus truei.*

4. Eggs pigmented.

5. Eggs in loose irregular cylinders or bands and files or strings.

6. Mass a loose irregular cylinder or band; attached along plant stems, blades of grass, or between two adjacent plants.

7. Two gelatinous envelopes present. Cylindrical mass 6.0-25.0 mm. in diameter containing 10-42 eggs. Complement of 300-500 per female. Masses deposited in temporary pools attached to plant stems, grass, or upper surface of small rocks. The greenish olive vitellus is 1.0-1.62 mm.; inner envelope 1.63-1.94 mm.; outer envelope 3.25-4.44 mm.; occasionally attached to vegetation by a stalk 5-10 mm. long. Range, California to lower California, east through Arizona, southwestern Colorado, New Mexico, to Texas and Mexico. Season, mid-February to August ..... *Scaphiopus hammondii hammondii.*

7. One gelatinous envelope present.

8. Envelope 2.5-3.5 mm.; loose. Vitellus 1.4-1.6 mm.; black above and cream below. 45-125 eggs close together in a rather firm cylinder 6.0 mm. across. 350-500 eggs per female. Attached to vegetation in water usually less than six inches in depth. Range, Texas to Arizona and Utah, northern Mexico and lower California. Season, April to August ..... *Scaphiopus couchii.*

8. Envelope 3.8-5.6 mm.; loose. Vitellus 1.4-2.0 mm.; black or brown above and white or cream below. 200 eggs in a loose mass 1-3 inches wide and 1-12 inches long; deposited along stems of plants or blades of grass. 2,330 eggs per female. Range, from West Virginia and Ohio down Ohio River to southeastern Missouri and northeastern Arkansas, across extreme southeastern Texas and along the Gulf and Atlantic coast to Massachusetts. Season, April to August ..... *Scaphiopus holbrookii holbrookii.*

6. Mass consisting of files or strings.

7. Files or strings without continuous gelatinous encasing; like a string of beads.

8. Two gelatinous envelopes present. File of 10-42 eggs; complement of 300-500 per female. Deposited in temporary pools on upper surface of small rocks. The greenish-olive vitellus is 1.0-1.62 mm.; inner envelope 1.63-1.94 mm.; outer envelope 3.25-4.44 mm. Range, California to lower California east through Arizona, southwestern Colorado, New Mexico, to Texas and Mexico. Season, mid-February to August ..... *Scaphiopus hammondii hammondii.*

8. One gelatinous envelope present.

9. Envelope small, 1.2-1.4 mm.; firm. Vitellus 0.8-1.0 mm.; black or brown above and white to yellow below. Eggs deposited in bars 4-10 mm. long of 2-10 eggs; on bottom or at surface attached to sticks, grass blades, etc.; in practically any type of pond. Separate or in a cluster radiating from one focus. Complement per female of 600-800. Range, North Carolina to Florida, west to Louisiana. Season, May to September ..... *Bufo quercicus.*

9. Envelope larger, 3.2-6.7 mm.

10. Envelope 3.2-3.6 mm.; very sticky. Vitellus 1.0-1.3 mm.; black above and white below. Files short; deposited on bottom of small, shallow rockbound pools. Range, Kansas, Arkansas, western Texas, Arizona, Utah, Colorado, Nevada, deserts of southeastern California and lower California. Season, April to September with May, commonest month ..... *Bufo punctatus.*

10. Envelope 6.7 mm. Vitellus 2.3 mm.; black above and white or gray below. Several hundred eggs per female. Strings

short or several inches long, commonly become attached to each other forming a network. Deposited near shore strung over vegetation at or near the surface. Range, eastern and central Texas, Oklahoma and western Arkansas. Season, April to June ..... *Scaphiopus holbrookii hurterii.*

7. Files or strings with a continuous gelatinous encasing.

8. One envelope present.

9. Envelope more than 5.0 mm. in diameter; 5.62-6.12 mm., average 5.77 mm.; distinct and relatively firm. Vitellus 1.25-1.62 mm. average 1.42 mm.; black above and gray below. Average of 42 eggs per inch; several thousand per female. Deposited in tangled strings on bottom of pool among leaves, sticks, gravel, mud, etc. Range, coastal area of southern California from upper Salinas Valley to lower California on Rio Santo Domingo. Season, May and June ..... *Bufo californicus.*

9. Envelope less than 5.0 mm. in diameter (1.8-4.6 mm.).

10. Envelope 2.6-4.6 mm., average about 3.5 mm.; distinct and relatively firm. Vitellus 1.0-1.5 mm.; black above and tan to yellow below. One or two rows of 17-25 eggs per inch. Long strings, 8-10 feet, deposited in tangled mass around vegetation or debris in practically any type of pool or stream ..... *Bufo woodhousii.*

11. Western United States. Southeastern Oregon through Idaho, Montana, South Dakota to western Iowa and western Missouri, south through Kansas, Oklahoma and Texas to Mexico, west to Imperial Valley of California and up Colorado Valley to southeastern Nevada and through Utah to Idaho. Complement 25,650 per female. Season, March to July ..... *Bufo woodhousii woodhousii.*

11. Eastern United States. New Hampshire to eastern Texas, eastern Arkansas, Missouri, southeastern Iowa, eastward in Michigan, through Ohio, West Virginia to coast. Extensions up Hudson, Delaware, Susquehanna, Ohio and other rivers. Egg masses of 5,000 to 10,000. Season, April to mid-August ..... *Bufo woodhousii fowleri.*

10. Envelope 2.4 mm. or less (1.8-2.4 mm.).

11. Envelope slightly scalloped in appearance. Gelatinous tube tightly coiled. Envelope 1.8-2.4 mm., average 2.0 mm.; distinct. Vitellus 1.2-1.6 mm., average 1.4 mm.; brown or dark gray above and yellow below; 11 to 17 per inch. Long coils deposited in temporary pools. Range, southern Utah and Nevada, south into Mexico and east to Oklahoma and eastern Texas. Season, first of May to mid-July ..... *Bufo compactilis.*

11. Envelope not scalloped. Envelope 2.12-2.25 mm., average 2.20 mm.; rather loose, but distinct in outline. Vitellus 1.14-1.70 mm., average 1.40 mm.; black or dark brown above and light tan below. 12 to 28 eggs per inch. The long, 400 inches, rope-like strings of 7,500 to 8,000 eggs are deposited in temporary pools or shallow streams in water 12″ to 18″ deep; usually after first heavy summer showers. Range, Imperial Valley, California up the Colorado River almost to

Nevada, up Gila River almost to New Mexico and south into Sonora, Mexico. Season, May to July..... ..... *Bufo alvarius.*

8. Two envelopes present.
   9. Partitions separating individual eggs.
      10. Envelopes decidedly scalloped, almost bead-like. Envelopes appear laminated. Outer envelope 1.72 mm. at narrowest point, 2.05 mm. at thickest point in single row; 2.66 mm. in a double row; distinct and firm. Inner envelope 1.60 mm. Vitellus 1.20 mm.; black above and white below. The single or double strings rarely have a double row of eggs within one tube. The 20,000 eggs per female are deposited after heavy rains in temporary pools, permanent springs, and small streams; attached to debris near the bottom. Range, west of Mississippi River, Imperial Valley, California up the Colorado River to southeastern Nevada, through Salt Lake, Utah, Wyoming, Montana to Alberta, thence to extreme western Minnesota and Iowa, northwest Missouri, western 2/3 of Kansas and Oklahoma, south to Texas coast; also in Mexico. Season, April to September ..... *Bufo cognatus.*
      10. Envelopes not scalloped. Outer envelope 2.86-4.0 mm.; distinct but not firm. Inner envelopes 1.6-2.2 mm.; distinct. Vitellus 1.0-1.4 mm.; dark brown to black above and white to cream below; 15-17 eggs per inch. The long (200 feet or more) spiral tubes containing 4,000 to 12,000 eggs are deposited on the bottom of quiet pools and shortly collect sediment enough to render them almost invisible to the observer. Complement of 20,600 per female. Range, Manitoba eastward to Hudson Bay, Quebec and the maritime provinces. Minnesota, south through Iowa to eastern Kansas and Oklahoma, thence eastward to northern Georgia, along Appalachians to central Virginia, thence to the coast and northward to Nova Scotia. Season, March to late July .... *Bufo americanus americanus.*
   9. No partitions separating the individual eggs.
      10. Eggs in a single row within the jelly tube. Outer envelope 2.6-4.6 mm.; distinct and slightly emarginated. Inner envelope 2.2-3.4 mm.; indistinct. Vitellus 1.0-1.4 mm.; black above and grayish-white below. 8-12 eggs per inch. The coiled strings, often several feet long, of 2,500-3,000 eggs are deposited in temporary or permanent bodies of water. Attached to or woven about vegetation or debris. Fastened near the surface in deep pools or lake edges. Range, North Carolina to Florida, west to the Mississippi River. Season, late February to September..... ..... *Bufo terrestris.*
      10. Eggs predominately in a double row within the jelly tube.
         11. Outer envelope small, 2.8-3.2 mm.; indistinct. Inner envelope 2.6 mm.; definite; extremely close to the outer. Vitellus 1.2 mm.; brown to black above and white or cream below. 20-30 eggs per inch, average 26; touching each other or nearly so. Strings about three feet in length, sometimes attached to objects in the mid-plane of the pond. Range, Louisiana, east

and central Texas to Mexico and Costa Rica. Season, March to August ..... *Bufo valliceps.*

11–a. Outer envelope large, 4.89-5.29 mm., somewhat loose but distinct. Inner envelope 3.54-3.82 mm.; distinct. Vitellus 1.65-1.75 mm.; jet black above and white or cream below. 13-52 eggs per inch, average 27. Masses of 16,500 eggs deposited in long strings along margins of ponds and streams in shallow water, not deeper than 300 mm.; usually in water less than 150 mm. Range, vicinity of Walker Lake, western Nevada, most of California except the northeastern part and desert areas, south into lower California. Season, January to July ..... *Bufo boreas halophilus.*

b. As above, except vitellus 1.50-1.75 mm., but ranging from northeastern California to Colorado, thence north and west through western Montana to Puget Sound. Also to British Columbia and southwestern Alaska to Prince William Sound. Overlaps *B. b. halophilus* in eastern California as far south as Mono county. Season, March to September, crest during June and July ..... *Bufo boreas boreas.*

5. Eggs in lumps. Not as above.

6. Each egg with only one gelatinous envelope.

7. Mass plinth-like or globular, relatively firm.

8. Range, New Jersey pine barrens, south to Okefinokee Swamp, Georgia and South Carolina. Number of eggs per mass fairly small, 200-600. Mass 2½" × 2½" to 3"-4" × 1½"-2"; with a bluish tinge. Envelope 3.8-6.9 mm., average 5.4 mm.; distinct. Vitellus 1.4-1.8 mm., average 1.6 mm.; black above and cream or yellow below. Deposited near surface in ponds up to eight inches deep. Attached to vegetation or debris. Season, April to mid-August ..... *Rana virgatipes.*

8. Range, Eureka and Elko counties, Nevada; central and southern Idaho, Oregon and northern California. Number of eggs per mass larger, 2,400; eggs ¼"-¾" apart. Mass 3" × 3" to 8" × 6"; with a bluish cast; gathers much debris. Envelope 5.0-7.12 mm., average 6.33 mm. fairly distinct. Vitellus 1.81-2.12 mm., average 1.97 mm.; black above and light tan below. Deposited in shallow water near the margins of ponds. Season, March to ? ..... *Rana pretiosa luteiventris.*

7. Mass a loose, irregular cluster.

8. Envelope average large, 6.4 or 7.0 mm.

9. Envelope average 6.4 mm., range 5.0-7.8 mm., rarely 3.0 mm.; indistinct. Vitellus 0.9-1.2 mm.; black or brown above and white below. 15-300 eggs per mass, usually less than 100; complement 500-1459± per female. The mass is usually less than one inch in diameter and is deposited in clear pools attached to vegetation. Range, along the shores of Lake Ontario, westward through Ontario, Michigan, Wisconsin, Minnesota, North Dakota, Montana to Idaho, southward to northern Arizona and northern New Mexico. Eastern Kansas, southeastward through Oklahoma and Texas to Arkansas, possibly to northern Louisiana, thence through Tennessee and Kentucky to Ohio and western Pennsylvania. Season, March 20 to May 20 ..... *Pseudacris nigrita triseriata.*

(Smith (1934) disagrees with the above considerably, in describing (from Kansas) the egg as having two envelopes; the egg as having two envelopes; the outer normally not larger than 3.0 mm., the inner being 2.1 mm.).

9. Envelope average 7.0 mm., range 6.0-8.5 mm.; indistinct.

10. Vitellus 1.6 mm.; black above and white below. 10-50 eggs per packet, average number is 25. Complement per female of 300-1500. Deposited in shallow, quiet, temporary pools and ditches; attached to vegetation and debris. Range, southwestern Pennsylvania, western Maryland, southeastern Ohio, eastern Kentucky, West Virginia, northern Alabama, northern Mississippi and Tennessee. Season, March to July ..... *Pseudacris brachyphona.*

10. Vitellus 1.2-1.4 mm. Range, Minnesota to Hudson Bay, to upper British Columbia and Mackenzie through Montana, Saskatchewan and Alberta. Season, May to early June ..... *Pseudacris nigrita septentrionalis.*

8. Envelope average smaller, 2.6-4.5 mm.

9. Envelope average 2.6 mm., range 1.5-2.8 mm.; loose. Vitellus 0.5-1.0 mm.; brown above and white or cream below. The loose cluster contains about 160 eggs. Range, peninsular Florida. Season, February to mid-August ..... *Pseudacris nigrita verrucosa.*

9. Envelope larger, 3.6-4.5 mm.

10. Envelope average 4.5 mm., range 3.8-5.6 mm.; loose. Vitellus 1.4-2.0 mm., average 1.7 mm.; brown or black above and white or cream below. 200 eggs in the packet; complement of 2,332± per female. Deposited at or near the surface to vegetation or debris, in temporary or permanent ponds. Range, from West Virginia and Ohio down Ohio River to southeastern Missouri and northeastern Arkansas across extreme southeastern Texas and along the Gulf and Atlantic coasts to Massachusetts. Season, March to September ..... *Scaphiopus holbrookii holbrookii.*

10. Envelope average 3.6 or 4.0 ± 0.2 mm.

11. Envelope average 3.6 mm., range 3.2-4.0 mm.; loose. Vitellus 0.9-1.1 mm., average 1.0 mm.; black above and cream below. Masses deposited in marshy stretches, shallow ponds or edges of ponds where there is matted vegetation, sedge clumps or moss; attached to the matted vegeattion. Range, New Jersey, Pennsylsylvania to North Carolina and possibly into South Carolina and northwestern Florida. Season, February to mid-May ..... *Pseudacris nigrita feriarum.*

11. Envelope average 4.0 ± 0.2 mm.

12. Range, Texas, Oklahoma and Arkansas. Vitellus average 1.5 mm., range 1.20-1.80 mm.; brownish-gray above and cream or white below. Envelope 3.0-5.0 mm.; very loose, elastic and sticky; collects much debris. The 10-250 (usually 20-50) eggs in the mass average 5.5-7.2 mm. apart. 400-700 or more eggs per female. Deposited just under the water's surface, attached to weeds and water grasses in practically any pool except flowing

streams or lakes. Bunches hang down lobately from vegetation. Season, December to late May ..... *Pseudacris streckeri.*

12. Range, North Carolina to Georgia, Florida and possibly west along the Gulf to Louisiana, Alabama. Vitellus average 0.95 mm., range 0.90-1.0 mm.; brown above and cream or white below. Envelope 3.6-4.2 mm.; loose. Season, November to March ..... *Pseudacris ornata*

6. Each egg with two or three gelatinous envelopes.

7. Two envelopes present.

8. Mass a firm regular cluster.

9. Mass a sphere 2½ to 4 inches in diameter; containing 2,000 to 3,000 eggs.

10. Eggs brown above and yellow below. Outer envelope 3.6-5.0 mm., average 4.0 mm.; distinct. Inner envelope 2.3-3.0 mm., average 2.6 mm.; distinct. Vitellus 1.6-1.9 mm., average 1.7 mm. Mass usually deposited under 3-4 inches, but sometimes under 1-3 feet of water; attached to vegetation, twigs or debris. Range, from central plains to Atlantic seaboard. From the Gulf States to Hudson Bay. Season, last of April to mid-May ..... *Rana palustris.*

10. Eggs black above and white below.

11. Vitellus average 1.9 mm., range 1.8-2.4 mm. Inner envelope 3.6-5.8 mm., average 3.8 mm.; indistinct. Outer envelope 5.2-9.4 mm., usually 5.8-7.0 mm., average 6.4 mm.; distinct. Mass rarely six inches in diameter. Bluish masses deposited in shallow ponds near surface to six inches deep, occasionally as much as 2-3 feet. Attached to vegetation in any part of pond. Numerous clusters in small area. Range, from southern Minnesota and Wisconsin, south to Arkansas, Tennessee, northern South Carolina through Appalachians to Maryland, north to Nova Scotia, thence westward through Quebec to Sault Ste. Marie. Season, last half of March through April ..... *Rana sylvatica sylvatica.*

11. Vitellus average 1.67 mm., range 1.50-1.81 mm. Inner envelope 3.06-4.06 mm., average 3.48 mm.; indistinct. Outer envelope 4.25-5.43 mm., average 5.08 mm.; distinct. Deposited in ponds in woods or fields; attached to vegetation. Range, Alaska and Mackenzie across northern British Columbia, Alberta and Saskatchewan to Red River of the North, northern Minnesota, Wisconsin and Michigan. From Sault Ste. Marie eastward between Hudson Bay and Great Lakes drainages to Saguenay River and to Gaspé Peninsula. Northern border from Mackenzie and Alaska to Hudson Bay to Labrador. Season, March to July ..... *Rana sylvatica cantabrigensis.*

9. Mass a plinth 1-4 × 2-6 × 2-12 inches in size; containing 1,000 to 7,000 eggs.

10. Outer envelope large, 10-15 mm.; distinct. Inner envelope 5.0-6.0 mm.; indistinct. Vitellus 2.0-2.8 mm.; black above and white below; appear far apart in the mass.

1,100-1,500 eggs in a mass 8 × 6 inches. Deposited in shallow water unattached among grasses at edges of ponds; top layer of eggs at surface of water. Range, northern California to southeastern Alaska, and east to Montana and western Wyoming, through central Utah to northern Arizona. Season, February to July ..... *Rana pretiosa pretiosa.*

10. Outer envelope smaller, 7.0 mm. or less.

11. Vitellus average 2.48 mm., range 2.46-2.50 mm.; black above and white below. Outer envelope 4.5-5.0 mm.; distinct. Inner envelope 3.15 mm. The large (5-6 inches in diameter) mass of about 7,000 eggs is deposited in temporary pools of various sorts, attached to stems of grass. Range, from Rogers and Tulsa counties, Oklahoma, north through eastern Kansas, eastward across central Missouri and Illinois to Benton and Monroe counties, Indiana (possibly to Greene County, Ohio), and southward in the Mississippi Valley through western Kentucky and Tennessee to Pontotoc county, Mississippi. Season, early March to May ..... *Rana areolata circulosa.*

11. Vitellus average 2.0 mm. or less.

12–a. Vitellus average 2.0 mm., range 1.8-2.4 mm.; black above and cream to white below. Outer envelope 4.4-6.0 mm., average 5.3 mm.; distinct. Inner envelope 3.1-4.4 mm., average 3.9 mm.; distinct. The large mass (4 × 5 × 1 to 12 × 4 × 2 inches) containing about 5,000 eggs is deposited about one inch below the surface in water 6-9 inches in depth; attached to vegetation. Range, Beaufort county, North Carolina, southward throughout peninsular Florida. Season, February to mid-August ..... *Rana capito.*

b. Eggs probably as above; range, Gulf coast from St. Tammany Parish, Louisiana to Mobile county, Alabama ..... *Rana sevosa.*

12. Vitellus average 1.4-1.7 mm., range 1.0-2.0 mm. Inner envelope 1.5-3.4 mm. Outer envelope 2.5-7.0 mm. 1,000 to 5,000 or more eggs per mass.

13. Outer envelope average 5.0 mm. or larger.

14. Outer envelope average 5.0 mm., range 2.5-5.6 mm. (seldom as small as 2.5 mm., except immediately after deposition); distinct. Inner envelope 1.5-3.4 mm., avreage 2.25 mm.; distinct. Vitellus 1.0-2.0 mm., average 1.7 mm.; black above and white below. The 3,500 to 6,500 eggs appear close together in the firm, compact mass which is 3-6 × 2-3 inches. Deposited in open marshy expanses near the surface, usually attached to grasses or other vegetation but sometimes free. Range, widespread over North America, east of the eastern edge of the Pacific coast states, from the extreme north into Mexico. Season, March to mid-May ..... *Rana pipiens.*

14. Outer envelope average 6.3 mm., range 5.6-7.0 mm., becoming 8.0-9.0 mm. with development, distinct. Inner envelope 2.4-3.0 mm., average 2.7 mm.; distinct. Vitellus 1.3-1.6 mm., average 1.4 mm.; brown to black above and buff to creamy yellow below. The mass which is 2″ × 2″ × 1″ to 6″ × 3″ × 2″ (usually 3-5 × 2) is deposited 2 inches to 5 feet below the surface in water up to eight feet in depth. Attached to vegetation. Range, northern New England and northern New York, west to Minnesota, north in Canada to Hudson Bay, Metacumbe and farther northward. Season, June 24 to August 16. ..... *Rana septentrionalis.*

13. Outer envelope average 3.8 mm., range 3.4-5.4 mm.; distinct. Inner envelope 2.4-3.2 mm.; distinct. Vitellus 1.4-1.8 mm., average 1.6 mm.; black above and buff to yellow below. The 1,000 to 1,500 or more eggs, in a mass 1-2 × 2-4 × 5-6 inches, are deposited at the surface or as much as 6 inches below, attached to stems of plants in temporary or permanent pools. Range, southeastern states, north along the coast to Virginia or New Jersey. Up the Mississippi River to Indiana and Kentucky. Season, any month of the year depending on the location; crest from April to August ..... *Rana sphenocephala.*

8. Mass a loose cluster, usually one inch or less in diameter.

9. Cluster elliptical. Normally 10-50 eggs per mass, occasionally as many as 250. Sometimes attached to objects by stalk of jelly. Eggs black above and white below. Deposited in muddy or clear pools of all sorts near the bottom; attached to vegetation or objects projecting from the bottom at edge of water; masses close together. Range, Kansas, Nebraska, North and South Dakota, south to Oklahoma, northwestern Texas, New Mexico and Idaho. Season, last of May to August ..... *Scaphiopus bombifrons.*

9. Cluster irregular.

10. Outer envelope small, 2.2-2.4 mm.; loose but rather distinct. Inner envelope 1.4-1.8 mm.; distinct. Vitellus 0.65-1.3 mm.; average 1.0 mm.; citrine drab above and yellow to white below. 13-30 eggs per packet; attached to plant stems; several packets close together, 1-1.5 inches apart. 150-175 eggs per female. Range, Texas, Oklahoma and Kansas. Season, March 5 to May 20 ..... *Pseudacris nigrita clarkii.*

10. Outer envelope larger, 3.0-6.7 mm.; indistinct.

11. Outer envelope 4.7-6.7 mm.; sticky. Inner envelope 1.88-2.70 mm., average 2.0 mm.; distinct. Vitellus 1.23-1.35 mm., average 1.3 mm.; brown above and yellow below. 9-70 eggs per packet, usually about 22-25. 730 to 1,250 eggs per female. Packets deposited in shallow water of any sort of quiet pond; attached to

vegetation. Several masses laid close together, one against the other, or separated less than one inch. Range, Vancouver Island and British Columbia to lower California; east to western Montana, Idaho, Utah, Nevada and Arizona. Season, January to mid-May ..... *Hyla regilla.*

11. Outer envelope 3.0 mm. Inner envelope 2.1 mm. Vitellus 0.9-1.2 mm.; black or brown above and white below. 15-300 eggs per mass, usually less than 100; complement 500 to 1,459± per female. The mass is usually less than one inch in diameter and is deposited in clear pools attached to vegetation. Range, along the shores of Lake Ontario, westward through Ontario, Michigan, Wisconsin, Minnesota, North Dakota, Montana to Idaho southward to northern Arizona and northern New Mexico. Eastern Kansas southeastward through Oklahoma to Arkansas, possibly to northern Louisiana, thence through Tennessee and Kentucky to Ohio and western Pennsylvania. Season, March 20 to May 20 ..... *Pseudacris nigrita triseriata.*

7. Three envelopes present.

8. Outer envelope 3.88-4.47 mm., average 4.0 mm.; jelly firm. Middle envelope 2.58-3.35 mm., average 2.8 mm. Inner envelope 2.32-2.94 mm., average 2.5 mm. All envelopes distinct. Vitellus 1.93-2.48 mm., average 2.2 mm.; black above and white below. Mass like a compact cluster of grapes, 2 × 2 × 1-1/5 to 2 × 4 × 2-2/5 inches in dimensions. Individual eggs on surface distinct. Eggs are firmly attached to each other. 919-1,037± eggs in the mass. Deposited in shallow water near the margins of streams, attached to stones in stream bed. Pick up much sediment. Range, western Oregon, northern and central portions of California, chiefly west of the high Sierra Nevada. Season, latter part of March to first of May ..... *Rana boylii boylii.*

8. Outer envelope 6.43-14.0 mm.

9. Number of eggs per mass 425 or less.

10. Outer envelope 6.43-7.87 mm., average 7.19 mm. Middle envelope 4.25-5.0 mm., average 4.60 mm. Inner envelope 3.75-4.81 mm., average 3.93 mm. All envelopes distinct. Vitellus 1.81-2.30 mm., average 2.17 mm.; black above and light gray-tan below. Plinth-like mass about 28 × 40 mm., with eggs 1/4-1/2 inch apart. The mass of 100 to 350 eggs is deposited near the banks of small streams, attached to stems of sedge etc. or to the bank itself. Range, southern half of Sierra Nevada, above 7,000 feet, California. Vicinity of Lake Tahoe and Lake Rose, Nevada, south to Tulare county, California. Season, June to August ..... *Rana boylii sierrae.*

10. Outer envelope 11.3± mm. Middle envelope 5.8 mm. Inner envelope 4.9 mm. All envelopes distinct. Vitellus 2.25 mm.; black above and cream below. Mass contains 425 eggs, which is the complement per female. Range, Washington and northern Oregon, possibly Idaho, British Columbia and Alaska. Season, last half of May to first half of July ..... *Rana cascadae.*

9. Number of eggs per mass 750 ot 4,000.

10. All gelatinous envelopes indistinct, particularly the middle. Outer envelope 10.0-14.0 mm. Middle envelope 6.25-7.93 mm., average 6.80 mm. Inner envelope 4.0-6.68 mm., average 5.70 mm. Vitellus 2.31-3.56 mm., average 3.04 mm.; black above and creamy-white below. 750 to 1,300 eggs in flat masses 6-10 inches across. Vitelli ¾ inch apart. Jelly of mass loose and viscid with a bluish cast. Individual eggs 1.2 cc. in volume. Masses deposited at surface of water attached to vegetation. Range, British Columbia, Washington, Oregon and south along the coast of California to Eureka. Season, March to July ..... *Rana aurora aurora.*

10. All gelatinous envelopes quite distinct, middle one particularly dense and distinct. Outer envelope 7.55-11.80 mm., average 8.5 mm. Middle envelope 3.94-6.40 mm., average 4.40 mm. Inner envelope 3.10-5.0 mm., average 3.5 mm. Vitellus 2.06-2.81 mm., average 2.1 mm.; black above and creamy-white below. The 2,000 to 4,000 eggs are in a soft viscid mass 2-3/5 × 4 × 3 to 6 × 4 × 4 inches. Outline of individual eggs evident on the surface. Masses deposited in overflow areas of permanent pools; attached to vegetation just below the surface in water 3-6 inches deep. Range, Oregon to lower California; introduced into Nevada. Season, January to March; crest January and February ..... *Rana aurora draytonii.*

Comments

This section is for the purpose of filling out the information that is lacking in the key proper. Each of the presently recognized, and also debatable, forms is mentioned so as to give a brief concept of what is known regarding the Salientian eggs up to the present time. Available data not included in the key are given here; mention is made of some of the facts needed for completing our knowledge of various eggs. What little is on record concerning the thirty-two forms not in the key is included at this point.

Leptodactylus labialis (Cope). No diagram. Most of our information on this form comes from Mulaik (1937), while Kellogg (1932) gives a few items that apply to the genus *Leptodactylus* in general. Range in the number of eggs deposited is fairly considerable, being from 75 to 200 with 80 as normal number. Place of deposition is, according to the above authors, near the water or in bare contact with it, but never in a body of water proper. Wright (1936, Ms.) states that eggs are laid under rotten logs. While no gelatinous encasings surrounds the eggs, they are, however, held in a group by a frothy mass 7 to 8 cm. in diameter. A complete description is sorely needed.

Eleutherodactylus augusti (Duges). No diagram. Not in the key. No eggs of this species are on record. The taxonomic status is still unsettled.

Eleutherodactylus latrans (Cope). No diagram. The known facts concerning the eggs of this form are extremely meager. Nothing seems to be known about the eggs themselves except the size of the vitellus and that the complement per female is about 50. Breeding season for the form is apparent-

ly extensive during any rainy period from February to May; Kellogg (1932) mentions that the eggs hatch in winter.

Eleutherodactylus ricordii (Dumeril and Bibron). See diagram. Information is here again scarce; nothing is known other than what has been included in the key. (Deckart, 1921; Dunn, 1926; Kellogg, 1932; Wright, 1936, 1942).

Syrrhophus campi Stejneger. No diagram. Outside of the size of the vitellus and the number of eggs deposited nothing is on record specifically concerning the eggs. (Wright, 1936, 1942).

Syrrhophus marnockii Cope. No diagram. Nothing known other than what has been stated in the key (Wright, 1936, 1942).

Ascaphus truei Stejneger. See diagram. The key embodies all known facts. (Wright, 1936, 1942).

Scaphiopus bombifrons (Cope). No diagram. Most urgently needed data on this form are measurements of vitellus and envelopes. Further investigations as to the numbers of eggs per mass and per female also are needed, along with a more precise description of the appearance of the mass. (Bragg, 1941; Gilmore, 1924; Wright, 1936, 1942).

Scaphiopus couchii Baird. See diagram. Egg masses of this species might at first glance appear to be portions of strings of some *Bufo*. They are attached to grass, weeds or roots; to either horizontal or vertical stems. More descriptions of the various appearances of the mass are in order. (Kellogg, 1932; Wright, 1936, 1942).

Scaphiopus hammondii hammondii Baird. See diagram. The egg mass of this species may be either a loose cylinder or similar to a loose string of beads; when appearing as a string, the string is short. Deposition is made following rains in muddy, temporary pools. The masses are submerged under one to four inches of water and are attached to vertical stems. Occasionally these toads fasten the mass one layer thick to the upper surface of small rocks. Vitelline capsules range from 1.50 to 1.73 mm. in diameter; the thin inner membrane is close around this capsule. (Bragg, 1941; Dickerson, 1906; Englehardt, 1918, 1925; Snyder, 1920; Wright, 1936, 1942).

Scaphiopus hammondii intermontanus (Cope). No diagram. Not in the key. This subspecies does not appear in the key for data are too meager. All that is on record is from Snyder (1920) mentioning that the eggs were deposited one layer thick attached to the surface of small rocks on the bottom of ponds. One to two masses were adjoining.

Scaphiopus holbrookii holbrookii (Harlan). See diagram. Masses of this form are elongated, irregular cylinders; the length varying with the depth of the pond in which they are laid, being about as long as the water is deep. In shallow ponds the mass may be one to six inches long, in ponds up to eighteen inches deep the mass may be as long as twelve inches. Bodies of water chosen are temporary pools or permanent ponds. (Babbitt, 1937; Brimley, 1940-41; Dickerson, 1906; Driver, 1936; Overton, 1914; Sherwood, 1898; Wright, 1924, 1931, 1936, 1942).

Scaphiopus holbrookii albus (Garman). No diagram. Not in the key. Nothing is on record concerning the eggs of this form. (Wright, 1936, 1942).

Scaphiopus holbrookii hurterii (Strecker). See diagram. Bragg (1944) has supplied us with practically all of our information regarding this form. More observations should be put on record which contain data concerning the number of eggs per mass and per female; also range of dimensions of the various components of the egg. Likewise the duration of the breeding season is incompletely known. (Bragg, 1944; Wright, 1936, 1942).

Bufo alvarius Girard. See diagram. These eggs are deposited in water four to eighteen inches in depth. Individual vitelli range from spheres to broad wedges within the jelly tube and are surrounded by vitelline capsules ranging from 1.25 to 1.70 mm., averaging 1.6 mm. Here again the length of the breeding season has been inadequately investigated. More ecological data should be recorded. (Kellogg, 1932; Livezey & Wright, 1945; Storer, 1925; Wright, 1936, 1942).

Bufo americanus americanus Holbrook. See diagram. Perhaps the best known of the *Bufo* eggs. Babbitt (1937) descriptively compares the tube to a corkscrew or chicken intestine. The eggs are always in a single row within the tube, which may be single or double. (Dickerson, 1906; Sherwood, 1898; Smith, 1934; Wright, 1914, 1924, 1936, 1942).

Bufo americanus copei Yarrow and Henshaw. No diagram. Not in the key. Eggs of this form are not on record.

Bufo boreas boreas (Baird and Girard). See diagram of following form. Very similar to *B. b. halophilus*. Some personal measurements on pretty badly smashed material seem to indicate that the eggs may be somewhat smaller, at least in the dimensions of the envelopes, than *B. b. halophilus*. Number of vitelli per inch is less also. Logier (1932) informs us that the masses are deposited in water six to eight inches deep. Much better descriptions should be published on this form.

Bufo boreas halophilus (Baird and Girard). See diagram. The vitelline capsule is very close to the vitellus in this form; vitelline capsule ranges from 1.70 to 1.75 mm. Vitelli are in two or three rows within the jelly tube, seldom one row. (Storer, 1925; Wright, 1936, 1942).

Bufo boreas nelsoni Stejneger. No diagram. Not in the key. Wright (1942) gives the information that the eggs are coiled around water plants; the toads breeding in shallow mucky pools two to eight inches deep. Other than this there is nothing on record.

Bufo californicus (Camp.) See diagram. Up until this time, there has appeared no description of the eggs of this species. Masses of long tangled strings of several thousand eggs are laid on the bottom of ponds among leaves, sticks, gravel, mud, etc. There is an average of 42 eggs per inch in the string. Vitelli are black above and grey below, ranging from 1.25 to 1.62 mm., average 1.42 mm. The vitelline capsule is very close to the vitellus, ranging from 1.37 to 1.68 mm. in diameter, average 1.62 mm. Only one gelatinous envelope is present; this is distinct, fairly firm and measures 5.62 to 6.12 mm.,

average 5.77 mm. The jelly is adhesive causing the coils of the strings to become attached to one another. *Bufo californicus* eggs closely resemble those of *B. b. halophilus* in all respects. More ecological data are needed.

Bufo canorus Camp. No diagram. Not in the key. Eggs of this species are not on record. (Wright, 1936, 1942).

Bufo cognatus (Say). See diagram. Bragg (1936, 1937, 1940) supplies us with a fairly complete description of the eggs of this species. There may be either single or double continuous strings of eggs laid. More could be learned about the breeding dates in the various parts of the animals' range.

Bufo compactilis Wiegmann. See diagram. Most needed information on the eggs of this species are numbers of eggs per mass, complement per female, situations under which eggs are deposited, types of localities used for deposition and further data on dates of breeding. Investigation in varied locales would also be of value. (Strecker, 1922; Wright, 1936, 1942).

Bufo debilis Girard. No diagram. Not in the key. These eggs are deposited in small strings attached to grass and plant stems (Strecker, 1926). No other data have been published.

Bufo exsul Myers. No diagram. Not in the key. Not on record. Species just recently (Myers, 1942) described.

Bufo hemiophrys Cope. No diagram. Not in the key. Nothing on record concerning eggs of this species except that they breed along the shallow edges of lakes and ponds (Wright, 1942).

Bufo insidior Girard. No diagram. Not in the key. Nothing on record.

Bufo marinus (Linné). No diagram. Not in the key. Not described to any degree. Danforth (1925) mentions that the strings are deposited "in the crannies in the side of the wall."

Bufo punctatus Baird and Girard. See diagram. This species is peculiar in that it chooses very small pools in solid rock or completely rockbound pools in canyon streams as places to deposit its eggs. The various reports as to how the eggs are laid (singly, short files or loose, scattered mass on the bottom) indicates the need for more information in this line. (Bragg & Smith, 1943; Kellogg, 1932; Storer, 1925; Strecker, 1922; Wright, 1936, 1942).

Bufo quercicus Holbrook. See diagram. Short bead-like rods, often several radiating from one focus makes these eggs easy to recognize. The depth at which the eggs are deposited could stand considerable more investigation. (Deckert, 1914; Wright, 1924, 1931, 1936, 1942).

Bufo terrestris (Bonnaterre). See diagram. When freshly deposited the inner envelope is not very apparent; the vitelline capsule may be elliptical. Information on this species is relatively complete. (Wright, 1924, 1931, 1936, 1942).

Bufo valliceps Wiegmann. See diagram. Method of attachment of these eggs has not been too well described. Strings may be single or double. (Page, 1919; Wright, 1936, 1942).

Bufo woodhousii woodhousii Girard. See diagram of *B. w. fowleri*. Very

similar to *B. w. fowleri*. Up to 25,000 or more eggs in the mass. (Bragg, 1940, 1941; Smith, 1934; Wright, 1936, 1942).

Bufo woodhousii fowleri (Hinckley). See diagram. The vitelline capsule is fairly close to the vitellus, being 1.20 to 1.50 mm. in diameter. Knowledge of the eggs of this form is fairly complete. Five thousand to 10,000 eggs in the mass. (Cagle, 1942; Wright, 1924, 1936, 1942).

Acris gryllus gryllus (LeConte). See diagram. On rare occasions this form lays eggs with an inner envelope measuring 1.6 to 1.8 mm. in diameter; how frequently this occurs, or whether it is more common in a particular locality, is open to further study. The total complement per female should also receive further attention. At times the single eggs tend to bunch. (Babbitt, 1937; Carr, 1940; Wright, 1924, 1931, 1936, 1942).

Acris gryllus crepitans Baird. See diagram. Not in the key. This form does not appear in the key as a separate entity for the few measurements available are identical with those of *A. g. gryllus*. More work is needed on this form. Ranges of the two *Acris* overlap in the southern states but *A. g. crepitans* extends as far north as Connecticut and the Canadian northwest. (Bragg, 1942; Wright, 1936, 1942).

Pseudacris brachyphona (Cope.) See diagram. Eggs of this species resemble those of *P. n. triseriata*. Each egg has a volume of about 0.26 cc. and adheres strongly to adjacent eggs. Attachment of masses is at petioles, margins and apices of dead leaves; also to twigs, grasses or trash that may be in the breeding pond. (Barbour & Walters, 1941; Green, 1938; Walker, 1932; Wright, 1936, 1942).

Pseudacris brimleyi Brandt and Walker. No diagram. Not in the key. Eggs of this species are not on record.

Pseudacris nigrita nigrita (LeConte). No diagram. Not in the key. Very little concerning the eggs of this form has been published. Dickerson (1906) says the light brown and pale yellow eggs are in masses of 5 to 20, deposited in shallow water attached to twigs and grass. Brandt (1936) tells us that the masses consist of 75 eggs attached to vegetation below the water's surface, and that the complement per female is 160. (Also Wright, 1931, 1936, 1942).

Pseudacris nigrita clarkii (Baird). See diagram. The packets of eggs of this form are loose and irregular. More study from varied localities is desirable. (Wright, 1936, 1942).

Pseudacris nigrita feriarum (Baird). See diagram. This form has, as yet, not received too close attention; Wright (1936 Ms. and 1942) published on it. Data on the number of eggs per mass and total complement per female are needed. The mass is quite loose and irregular.

Pseudacris nigrita septentrionalis (Boulenger). See diagram. Quite similar to the eggs of *P. brachyphona*. Much is still lacking in published records; such things as pigmentation, number of eggs per mass, complement per female, place of deposition and other ecological data are not on record. (Wright, 1936, 1942).

Pseudacris nigrita triseriata (Wied). See diagrams. Data on this form are

conflicting. The great discrepancy between Wright (1924, 1936 Ms., 1942) and Smith (1934) seems to indicate a great need for studying all forms more closely in the field under varying conditions and in widely separated localities. The fact that there should be such disagreement as to the number of envelopes present, the dimensions of the component parts of an egg and the number of eggs per mass would lead one to suspect that conditions under which the specimens were described were not at all similar (age of eggs, preservation, etc.). Examination of some eggs collected by A. R. Cahn, 1935, and obtained from the AMNH (No. 23276) favors the former's description of this species. Even though the specimens were shipped in alcohol, the diameters of the envelope measure from 4.00 to 4.50 millimeters. The individual eggs in the mass had not separated. No inner envelope was at all apparent as Smith describes. Assuming that the eggs had been in alcohol under cool conditions since time of shipment, about 0.5 mm. of the mucoprotein composing the envelope should have been dissolved away; hence, the measurements of Smith seem exceedingly small. (Also Babbitt, 1937; Bragg, 1941; Pack, 1920).

Pseudacris nigrita verrucosa (Cope). See diagram. Very little field data has been put on record in regard to this form. All that is known concerns the measurements of the egg components and the remark that the mass resembles that of *P. n. feriarum* and is made up of 160 eggs (observations on one animal in the laboratory), Brady and Harper (1935).

Pseudacris occidentalis (Baird and Girard). No diagram. Not in the key. Nothing on record. Taxonomic status uncertain.

Pseudacris ocularis (Holbrook). See diagram. This species lays its eggs in water three to twelve inches deep. More ecological data are needed here. Only one investigator has studied the eggs of this form. (Wright, 1924, 1931, 1936 Ms., 1942).

Pseudacris ornata (Holbrook). See diagram. Little is on record relating to these eggs other than measurements and pigmentation observations by Wright (1936 Ms., 1942).

Pseudacris streckeri Wright and Wright. See diagram. The small bunches of eggs of this species are often joined by thin sheets of jelly. A few additional field descriptions of the masses would be useful. (Bragg, 1942; Strecker, 1926; Wright, 1936, 1942).

Hyla andersonii Baird. See diagram. More extensive study in general is needed on this species. (Noble, 1923; Wright, 1931, 1936, 1942).

Hyla arenicolor Cope. See diagram. Further data on the complement per female, depth at which eggs are deposited and types of bodies of water used for breeding should be obtained. (Campbell, 1934; Storer, 1925; Wright, 1936, 1942).

Hyla avivoca Viosca. No diagram. Not in the key. Records have never been published concerning the description of eggs of this species. (Mittleman, 1945; Wright, 1942).

Hyla baudinii (Dumeril and Bibron). No diagram. Not in the key. Nothing on record.

Hyla cinerea cinerea (Schneider). See diagram. Further elucidation on type of pond or stream used for breeding, location and method of attachment and appearance of the mass is in order. (Wright, 1924 ,1931, 1936, 1942).

Hyla cinerea evittata (Miller). No diagram. Not in the key. Probably similar to *H. c. cinerea,* but nothing is known of the eggs of this form. Tidal marshes, lily ponds and reed beds are used as places for breeding according to Wright (1936 Ms., 1942). (Also Dickerson, 1906).

Hyla crucifer Wied. See diagram. This toad has no absolute preference as to depth of water in which it lays its eggs for they may be found under one inch of water or as deep as three feet. It is often quite difficult to find these eggs for they are deposited among matted vegetation or on the under side of submerged leaves. Several workers have paid considerable attention to this species and it has been quite thoroughly described. (Babbitt, 1937; Boyer & Heinze, 1934; Carr, 1940; Dickerson, 1906; Noble, 1923; Sherwood, 1898; Wright, 1914, 1924, 1931, 1936, 1942).

Hyla femoralis Latreille. See diagram. A few additional studies of the appearance of the mass and number of egg per packet would be of value. (Wright, 1924, 1931, 1936, 1942).

Hyla gratiosa LeConte. See diagram. A vitelline capsule far removed from the vitellus is the outstanding feature for distinguishing the egg of this species, but unless examined carefully, it may be interpreted as being a second gelatinous envelope. *H. gratiosa* deposits its eggs under three to six inches of water in open or grassy temporary ponds. (Deckert, 1915; Wright, 1924, 1931, 1936, 1942).

Hyla regilla Baird and Girard. See diagram. The vitelline capsule of this egg measures 1.29 to 1.41 mm. in diameter. Masses are attached to practically any kind of vegetation or debris in a pond, usually submerged but sometimes at the surface. Their resemblance to egg masses of some salamanders may at times be slightly confusing. (Dickerson, 1906; Storer, 1925; Wright, 1936, 1942).

Hyla septentrionalis Boulenger. No diagram. Not in the key. Carr (1940) gives temporary ditches, basements of wrecked buildings and cisterns as the locales for the breeding of this species. Other than this, nothing is on record.

Hyla squirella Latreille. See diagram. These single eggs are laid on the bottom of shallow ponds under one to three inches of water. Rarely a surface film is deposited, according to Pope (1919). (Also Wright, 1924, 1931, 1936, 1942).

Hyla versicolor versicolor (LeConte). See diagram. The surface masses of eggs of this species contain numerous air bubbles. Masses may be attached to plant stems, free or attached to floating vegetation or debris. (Babbitt, 1937; Cagle, 1942; Smith, 1934; Wright, 1914, 1924, 1931, 1936, 1942).

Hyla versicolor chrysoscelis (Cope). No diagram. Not in the key. Nothing on record. Taxonomic status uncertain.

Hyla versicolor phaeocrypta (Cope). No diagram. Not in the key. Nothing on record. Taxonomic status uncertain.

Hyla wrightorum Taylor. No diagram. Not in the key. Wright (1936 Ms.) measured ovarian eggs and found the vitellus to be 1.0 to 1.4 mm. in diameter. No other data are on record.

Rana areolata areolata Baird and Girard. No diagram. Not in the key. Nothing on record except that numerous masses are deposited in a small area (179 masses per ten square feet), in small temporary pools (Cagle, 1942).

Rana areolata circulosa Rice and Davis. See diagram. Further investigation in all respects and from different localities would be of value. Studied extensively only by Smith (1934).

Rana aurora aurora (Baird and Girard). See diagram. Vitelline capsules of these eggs measure 2.56 to 3.87 mm., average 3.28 mm. More study is needed regarding all aspects of these eggs. (Livezey & Wright, 1945; Wright, 1942).

Rana aurora draytonii (Baird and Girard). See diagram. Differs from *R. a. aurora* in that all envelopes are quite distinct and dimensions are noticeably smaller. Vitelline capsule measures 2.28 to 2.95 mm. Algal growths are commonly found in all envelopes. (Dickerson, 1906; Storer, 1925; Wright, 1936, 1942).

Rana boylii boylii (Baird). See diagram. The vitelline capsule of this form measures 1.98 to 2.53 mm. Other data in the key. (Storer, 1925; Wright, 1936, 1942).

Rana boylii muscosa Camp. No diagram. Not in the key. Nothing on record. The extent of the breeding season is not even known.

Rana boylii sierrae Camp. See diagram. Frequently there is an algal growth within the envelopes. The vitelline capsule is 2.25 to 2.75 mm., average 2.58 mm. Descriptions from varied localities are needed. (Livezey & Wright, 1945; Wright, 1936, 1942).

Rana capito LeConte. See diagram. *R. capito* deposits its egg masses in ponds with or without open centers, attached to any kind of brush or weeds. The top of the mass is often level with the surface of the water. (Wright, 1931, 1936, 1942).

Rana sevosa (Goin and Netting). No diagram. Not in the key. Is this form a species or subspecies? Eggs from *R. sevosa* are apparently identical with those of *R. capito*. Masses are laid under about one foot of water attached to plant stems (Goin and Netting, 1940).

Rana cascadae Slater. See diagram. Much is yet to be put on record regarding the number of eggs per mass, total number per female and the conditions under which the eggs are deposited. (Slater, 1939; Wright, 1942).

Rana catesbeiana Shaw. See diagram. This species deposits a mass of eggs greater in extent than any other of the Salientia; it is also one of the best known. (Babbitt, 1937; Smith, 1934; Storer, 1925; Wright, 1914, 1924, 1936, 1942).

Rana clamitans Latreille. See diagram. Another of the more easily recognized and better known surface films of eggs. Data fairly complete on this form. (Babbitt, 1937; Smith, 1934; Wright, 1914, 1924, 1931, 1936, 1942).

Rana fisheri Stejneger. No diagram. Not in the key. Nothing on record.

Rana grylio Stejneger. See diagram. Another of the small surface films, about twice the extent of *R. clamitans*. More ecological data are needed from varied places. (Wright, 1924, 1931, 1936, 1942).

Rana heckscheri Wright. No diagram. Not in the key. Very little seems to be known about the eggs of this species. Wright (1931, 1936 Ms., 1942) surmises the egg mass is a surface film and from ovarian evidence gives the size of the vitellus as 1.5 to 2.0 mm., black above and white below. The complement per female is given as 6,000 to 8,000.

Rana onca Cope. No diagram. Not in the key. Nothing on record. It is still taxonomically uncertain.

Rana palustris LeConte. See diagram. Information on this species is fairly complete. A well-known and easily recognized egg mass. (Babbitt, 1937; Dickerson, 1906; Smith, 1934; Wright, 1914, 1924, 1936, 1942).

Rana pipiens pipiens Schreber. See diagram. Much work has been done on this form, perhaps more than any other. The gradation in density of the jelly between the inner and outer envelopes at times suggest the presence of a third, middle envelope. Vitelline capsules measure 1.78 to 2.11 mm., average 1.97 mm. There is a wide range in size of all the components of the eggs of *R. p. pipiens*. (Babbitt, 1937; Dickerson, 1906; Smith, 1934; Wright, 1914, 1924, 1936, 1942).

Rana p. berlandieri (Baird). No diagram. Not in the key. Nothing on record. Taxonomic status doubtful.

Rana pipiens brachycephala (Cope). No diagram. Not in the key. Nothing on record. Taxonomic status doubtful.

Rana pretiosa pretiosa (Baird and Girard). See diagram. Each egg of this form is about 1.0 cc. in volume and appears far apart from its neighbors in the mass which is about a pint in bulk. (Dickerson, 1906; Svihla, 1935; Wright, 1936, 1942).

Rana pretiosa luteiventris Thompson. See diagram. The rather bluish looking masses of about 260 cc. volume gather considerable debris; the jelly is not too firm. Deposition is in water three or four inches deep. The vitelline capsule is 1.93 to 2.25 mm., average 2.06 mm. Unlike *R. p. pretiosa* this form has no inner envelope. Duration of the breeding season for this form is incompletely known. (Livezey & Wright, 1945; Wright, 1936, 1942).

Rana septentrionalis Baird. See diagram. These masses are attached to water plants in about the mid-plane of ponds or shallow portions of lakes. Sometimes they can be found on the sandy bottoms of lakes. More counts of the number of eggs per mass and per female should be made. (Babbitt, 1937; Wright, 1931, 1936, 1942).

Rana sphenocephala (Cope). See diagram. At times the masses may be found on the bottom of shallow pools. Twelve to fifteen inches is the normal depth of the pools used by this species in which it deposits its eggs; masses are laid about eight feet from the shore. (Wright, 1924, 1931, 1936, 1942).

Rana sylvatica sylvatica LeConte. See diagram. Numerous masses are deposited in a small area, oftentimes in contact with one another. Babbitt (1937) records masses with as few as 500 eggs in them, but this is not the usual case. (Also Dickerson, 1906; Overton, 1914; Wright, 1914, 1924, 1936, 1942).

Rana sylvatica cantabrigensis Baird. See diagram. This form is quite similar to its relative *R. s. sylvatica*, but seems to be somewhat smaller as a general rule. The vitelline capsule is adherent to the vitellus. Not enough measurements from varied localities have been made upon this form. (Wright 1936, 1942).

Rana sylvatica latiremis (Cope). No diagram. Not in the key. Nothing is on record. Undoubtedly very similar to the two above.

Rana tarahumarae Boulenger. No diagram. Not in the key. Nothing on record except that "the breeding season is evidently after the heavy summer rains which begin in July." (Campbell, 1931).

Rana virgatipes Cope. See diagram. Normal depth of ponds for deposition of egg masses of this species is three to four inches, the upper portion of the mass being about three-quarters of an inch under the surface. (Wright, 1924, 1931, 1936, 1942).

Microhyla areolata Strecker). No diagram. Not in the key. Nothing on record. This appears to be a synonym of *M. c. carolinensis* and *M. c. olivacea* or intermediate. It seems advisable in the *Microhyla* to follow the taxonomy as clarified by Hecht and Matalas (1946).

Microhyla carolinensis carolinensis (Holbrook). See diagram. Egg masses of this species contain numerous air bubbles and are deposited in any depression containing water. The water may be clear and fresh or stagnant of trashy, oily water. Each egg in the mass is very distinct, giving the appearance of glass marbles in a group. (Deckert, 1914; Dickerson, 1906; Wright, 1924, 1931, 1936, 1942).

Microhyla carolinensis mazatlinensis Taylor. No diagram. Not in the key. Nothing on record.

Microhyla carolinensis olivacea (Hallowell). See diagram. *M. c. olivacea* eggs differ in several respects from those of *M. c. cadolinensis*. The outer envelope is not so firm and distinct, the envelope is not truncate, there is a possibility of an inner envelope close to the vitellus and the masses are usually attached to the vegetation. More investigation may clarify the situation somewhat. (Smith, 1934; Strecker, 1926; Wright, 1936, 1942).

Hypopachus cuneus Cope. See diagram. Not too much is known of the eggs of this species. It is similar to *M. c. carolinensis* in that the envelope is truncate above, but the eggs are smaller. (Mulaik & Sollberger, 1938; Wright, 1936, 1942).

Eggs and Taxonomy

What value a study of the eggs of the Salientia has in relation to the taxonomic status of the animals has received practically no attention. Quite

apparent are the differences between some genera, for example the genus *Bufo* is so very unique in its eggs that no one would raise the question as to the continuity of the forms. Of course *Bufo punctatus* is very dissimilar in regard to the appearance of its eggs and method of deposition, but this is a singular case. Other than these broad family and generic groupings, there does appear to be some little value in examining the eggs of several of the species and subspecies in order to ascertain their phylogenetic relationships. Some of these will now be considered.

From figures five and six it may be seen that the very noticeable differences in the size of the vitelli and envelopes bears out the division of *Scaphiopus holbrookii* into the sub-species *holbrokii* and *hurterii*.

Pseudacris brachyphona and *Pseudacris nigrita septentrionalis* are so similar in the appearance of their eggs that one might suppose that they have even a closer relation than is at present assigned to them; see figures twenty-eight and thirty-one. The supposition may be carried further in an examination of the entire mass, for these also are quite similar.

There is more variation within the subspecies of *Pseudacris nigrita* than is noticeable between the above two forms as is evident from figures twenty-nine through thirty-three. Masses of these forms also have a greater diversity than exists between the masses of *P. brachyphona* and *P. n. septentrionalis*. Likewise the similarity between *Pseudacris ornata* and *Pseudacris streckeri*, figures thirty-five and thirty-six, is greater than the subspecies of the *nigrita* group, both in the mass and the individual eggs.

Evidence of the validity of the separation of *Rana aurora* into the subspecies *aurora* and *draytonii* is apparent from figures thirty-seven and thirty-eight. Here, not only are all of the diameters of the envelopes and vitelli different, but also the greater relative width of the inner envelope of *aurora* and the greater relative width of the middle envelope of *draytonii* lends support to this contention. The greater number of eggs per mass in *draytonii* (2,000 to 4,000) as compared with *aurora* (750 to 1,300) further emphasizes the point.

Figures thirty-nine and forty graphically bring out the differences between the subspecies of *Rana boylii*. In this instance the overall dimensions are easily distinguishable from the vitellus through the various envelopes.

Eggs of *Rana cascadae*, as shown in figure forty-one, are very much like those of *R. aurora* and *R. boylii* groups, particularly in respect to the number of envelopes. The diameters of the vitelli and envelopes are more like those of the forms of *aurora*. The relative proportions of the widths of the envelopes are remarkably similar to *R. a. aurora*. From these facts it would seem reasonable that *R. cascadae* is quite close phylogenetically to *R. aurora* and that all three groups are likewise related. Numbers of eggs per mass and general appearance of the mass would group *R. cascadae* more closely with the forms of *boylii*. But this aspect is always more variable than the finer details noted above. At any rate the indications are that there is an extremely close relation among the three groups mentioned.

The tendency of some workers to consider *Rana sphenocephala* as a sub-

species of *Rana pipiens* is not upheld by the morphology of their eggs. As seen in figures forty-seven and forty-eight there are other differences besides the total diameter of the ova. Relative widths of both inner and outer envelopes are just the reverse in the two forms; the outer envelope of *Rana pipiens* being much greater than in *R. sphenocephala* and the inner being much smaller.

Adults of *Rana pretiosa pretiosa* and *R. p. luteiventris* are so very much alike that this present division is not in accord with the views of several of our herpetologists. However, from the appearance of the eggs of these subspecies, this taxonomic status should remain. As may be seen in figures forty-nine and fifty, the eggs are entirely different. Not only is the diameter of the egg of *R. p. pretiosa* much larger, but it has present an inner envelope which is almost as large as the one envelope that exists in the egg of *R. p. luteiventris*. Size of the mass is similar in both forms, but the number of eggs per mass is somewhat greater in *R. p. luteiventris*.

Figures fifty-two and fifty-three illustrate the slight dissimilarities between the eggs of *Rana sylvatica sylvatica* and *R. s. cantabrigensis*. In this case *R. s. sylvatica* has an overall dimension greater than that of *R. s. cantabrigensis* and the outer envelope is relatively of greater width. The size of the vitellus is somewhat larger in *R. s. sylvatica*, but the relative width of the inner envelopes is approximately the same. In comparing these two subspecies, however, any conclusion must be held in abeyance for the dimensions of *R. s. cantabrigensis* were taken from a small number of eggs within a single mass.

Microhyla carolinensis carolinensis and *Microhyla carolinensis olivacea* have until recently (Hecht and Matalas, 1946) been regarded as distinct species. Figures fifty-six and fifty-seven show the appearance of eggs of these two. Other than the slightly greater size of *M. c. carolinensis* eggs and the definite truncation of the envelope, there is little difference between the two. Although the truncated envelope may seem significant to some, this point takes on less importance in view of the fact that the same sort of thing occurs in a different genus, as may be seen in figure fifty-eight. This figure represents the egg of *Hypopachus cuneus*, another of the brevicepitid frogs of this country. Perhaps to the minds of some this truncation may point to a closer relationship between *Microhyla* and *Hypopachus* than was heretofore accredited.

EXPLANATION OF FIGURES

Figs. 1-58. Diagrams of the Eggs.

All diagrams are figured at 2.5× normal size. Broken lines indicate indistinctness or looseness of envelopes. No vitelline capsules are shown, except in number 23, *Hyla gratiosa.*

Figs. 1-15. 1. *Eleutherodactylus ricordii.* 2. *Ascaphus truei.* 3. *Scaphiopus couchii.* 4. *Scaphiopus hammondii hammondii.* The only species of Scaphiopus with two envelopes. 5. *Scaphiopus holbrookii holbrookii.* 6. *Scaphiopus holbrookii hurterii.* 7a & b. *Bufo alvarius.* Note odd wedge-shaped vitelli in b, a common condition in this species. 8. *Bufo americanus americanus.* 9a & b. *Bufo boreas halophilus.* 10. *Bufo californicus.* 11. *Bufo cognatus.* 12. *Bufo compactilis.* 13. *Bufo punctatus.* The only Bufo that deposits eggs singly. 14. *Bufo quercicus.* 15. *Bufo terrestris.*

Figs. 16-35. 16a & b. *Bufo valliceps.* 17a & b. *Bufo woodhousii fowleri.* 18. *Hyla andersonii.* 19. *Hyla arenicolor.* 20. *Hyla cinerea cinerea.* 21. *Hyla crucifer.* 22. *Hyla femoralis.* 23. *Hyla gratiosa.* Vitelline capsule far removed from vitellus. 24. *Hyla regilla.* 25. *Hyla squirella.* 26. *Hyla versicolor versicolor.* 27a & b. *Acris gryllus.* Rarely laid as in b. 28. *Pseudacris brachyphona.* 29. *Pseudacris nigrita clarkii.* 30. *Pseudacris nigrita feriarum.* 31. *Pseudacris nigrita septentrionalis.* 32a, b & c. *Pseudacris nigrita triseriata.* Figure a is probably the true appearance of the egg; c is after Smith's (1934) description; b is a composite of a and c. See species comments. 33. *Pseudacris nigrita verrucosa.* 34. *Pseudacris ocularis.* 35. *Pseudacris ornata.*

Figs. 36-55. 36. *Pseudacris streckeri.* 37. *Rana aurora aurora.* 38. *Rana aurora draytonii.* 39. *Rana boylii boylii.* 40. *Rana boylii sierrae.* 41. *Rana cascadae.* 42. *Rana clamitans.* 43. *Rana capito.* 44. *Rana catesbeiana.* 45. *Rana grylio.* 46. *Rana palustris.* 47. *Rana pipiens pipiens.* 48. *Rana sphenocephala.* 49. *Rana pretiosa pretiosa.* 50. *Rana pretiosa luteiventris.* 51. *Rana septentrionalis.* 52. *Rana sylvatica sylvatica.* 53. *Rana sylvatica cantabrigensis.* 54. *Rana virgatipes.* *55. *Rana areolata circulosa.*

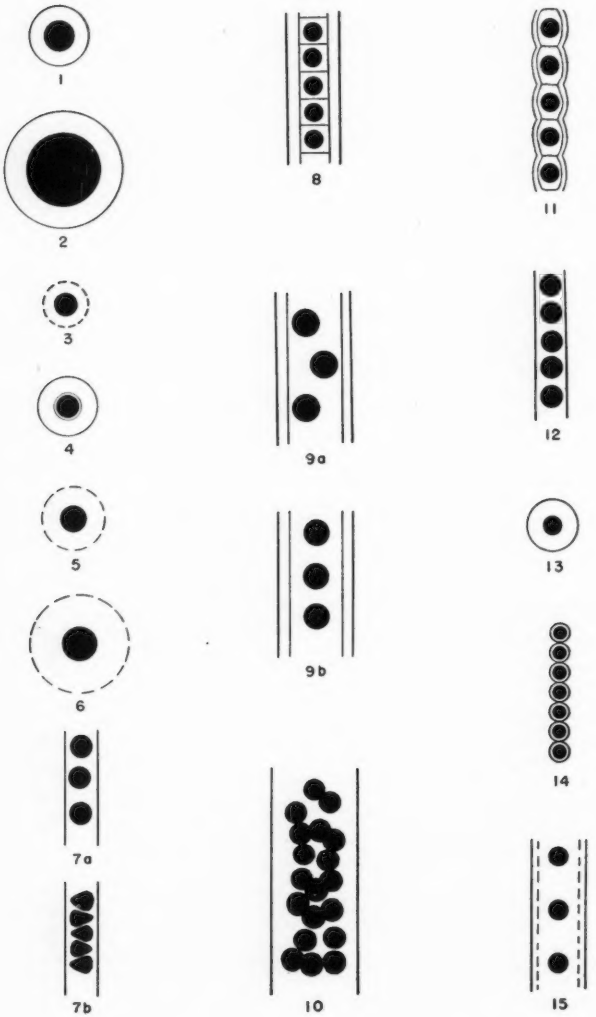
Figs. 56-58. 56. *Microhyla carolinensis carolinensis.* 57. *Microhyla c. olivacea.* 58. *Hypocachus cuneus.*

Figs. 59-82. Microphotographs of the Eggs.

Figs. 59-71. 59a & b. *Bufo alvarius.* a. 3.8×, b, 4.8×. 60. *Bufo americanus americanus.* 5.0×. 61. *Bufo boreas boreas.* 4.0×. 62a & b. *Bufo boreas halophilus.* a. 2.0×, 2. 2.64×. 63. *Bufo californicus.* 3.75×. 64a & b. *Bufo compactilis.* a. 3.0×, b. 3.0×. 65. *Bufo terrestris,* 4.37×. 66a & b. *Bufo valliceps.* a. 4.16×, b. 4.16×. 67a. & b. *Bufo woodhousii fowleri.* a. 5.7×, b. 5.7×. b. shows later linear arrangement of embryos. 68. *Pseudacris nigrita triseriata.* 3.1×. 69. *Hyla crucifer.* 5.0×. 70. *Hyla femoralis.* 5.0×. 71. *Hyla regilla.* 3.84×.

Figs. 72-82. 72a & b. *Rana aurora aurora.* a. 2.0×, b. 1.3×. b. shows egg stained to make loose outer envelope more visible. 73. *Rana aurora draytonii.* 2.85×. 74. *Rana boylii boylii,* 2.27×. 75a & b. *Rana boylii sierrae.* a. 3.68×, b. 3.0×. 76. *Rana clamitans.* 4.0×. 77a & b. *Rana palustris.* a. 4.67×, b. 4.1x. 78a & b. *Rana pipiens pipiens,* a. 3.2×, b. 4.67×. 79. *Rana pretiosa luteiventris,* 2.5×. 80a & b. *Rana sphenocephala.* a. 5.0×, b. 5.0x. 81. *Rana sylvatica sylvatica.* 2.6×. 82. *Rana sylvatica cantabrigensis.* 4.2×.

* This figure, *R. a. circulosa,* should follow 38, *R. a. aurora,* but an oversight in numbering places it out of position.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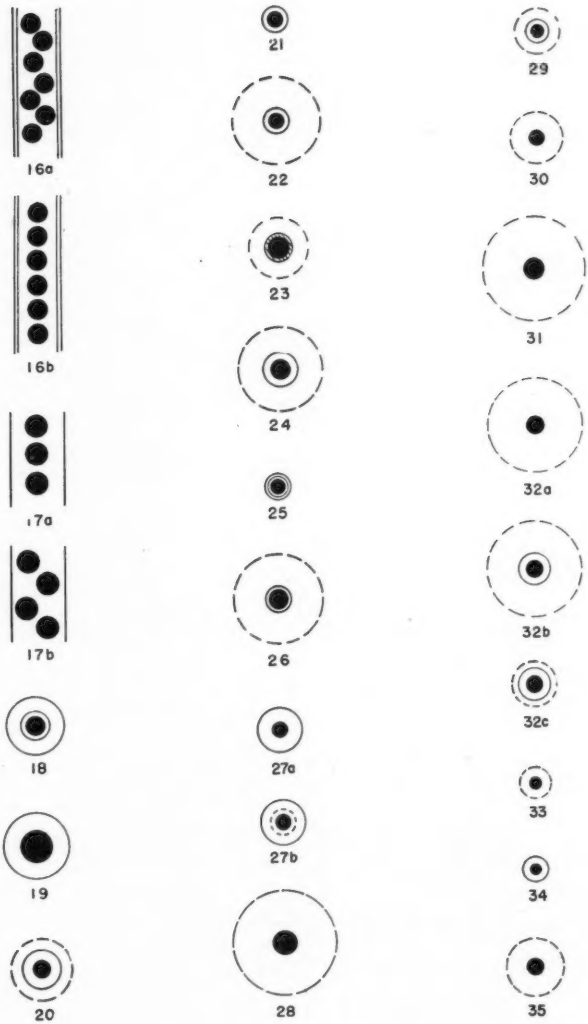
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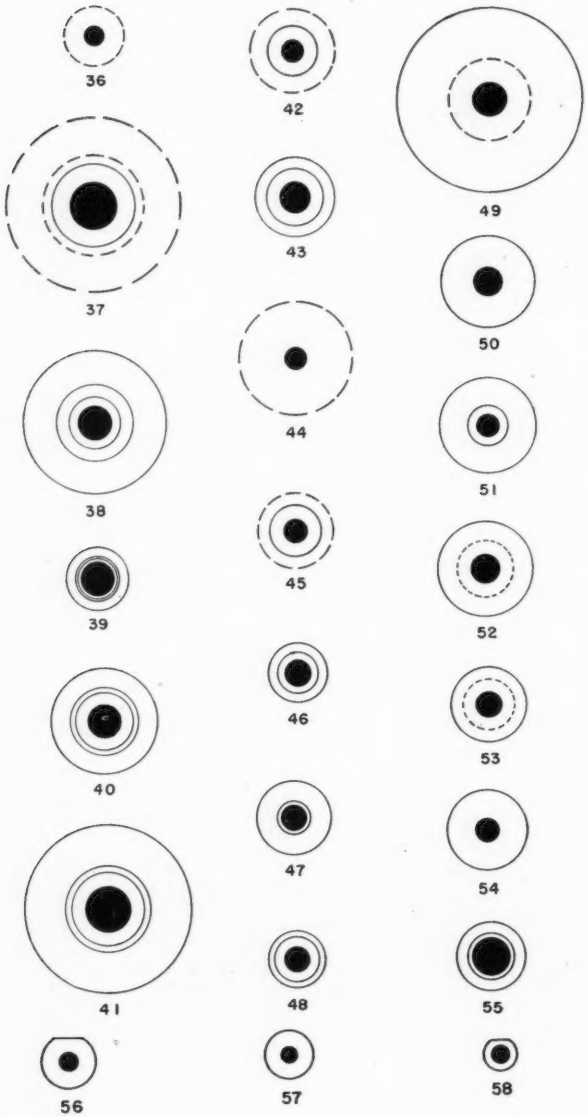
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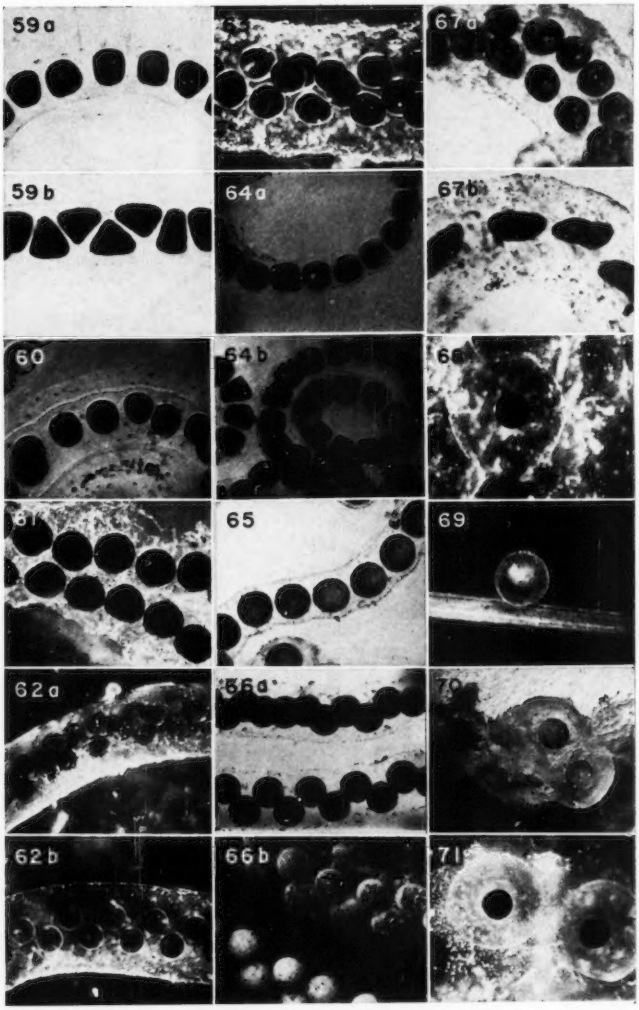
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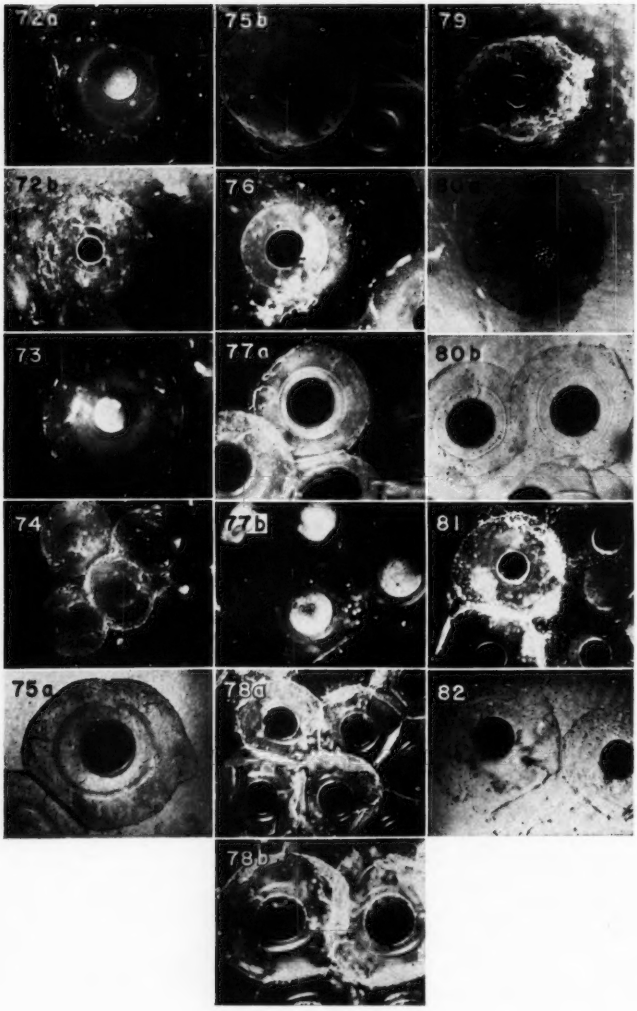
PLATE 6



REFERENCES

AHL, E. 1931—Das Tierreich. Anura III. Deuts. zool. Ges. **55**:1-477, Berlin und Leipzig.

BLES, EDWARD J. 1904-05—The life-history of *Xenopus laevis* Daud. Trans. Royal Soc. Edinburgh **41**(3), art. xxxi:789-821 (1904-06).

BOULENGER, G. A. 1896-1897—The tailless batrachians of Europe, parts I & II. The Ray Soc., London.

———1920—A monograph of the South Asian, Papuan, Melanesian and Australian frogs of the genus *Rana*. Records Indian Mus. **20**: 226 pp.

BOYER, DOROTHY A. AND ALBERT A. HEINZE. 1934—An annotated list of the amphibians and reptiles of Jefferson County, Missouri. Trans. Acad. Sci. St. Louis **28**(4):185-200.

BABBITT, LEWIS HALL. 1937—The amphibia of Connecticut. State Geological and Natural History Survey, State of Connecticut. Bull. **57**:1-50.

BARBOUR, ROGER W. AND ELMON P. WALTERS. 1941—Notes on the breeding habits of *Pseudacris brachyphona*. Copeia **1941**(2):116.

BRADY, M. K. AND F. HARPER. 1935—A Florida subspecies of *Pseudacris nigrita* (Hylidae). Proc. Biol. Soc. Wash. **48**:107-110.

BRAGG, ARTHUR N. 1936—Notes on the breeding habits, eggs, and embryos of *Bufo cognatus* with a description of the tadpole. Copeia **1936**(1):14-20.

———1937—Observations on *Bufo cognatus* with special reference to breeding habits and eggs. Amer. Midl. Nat. **18**(2):273-284.

———1940—Observations on the ecology and natural history of Anura. I. Habits, habitat and breeding of *Bufo cognatus* Say. Amer. Nat. **74**:322-349 and 424-438, July-Aug. and Sept.-Oct.

———1940—Observations on the ecology and natural history of Anura. II. Habits, habitat and breeding of *Bufo w. woodhousii* (Girard) in Oklahoma. Amer. Midl. Nat. **24**(2):306-335.

———1941—Some observations on amphibians at and near Las Vegas, New Mexico. Gt. Basin Nat. **2**(3):109-117.

———1942—Observations on the ecology and natural history of Anura. X. The breeding habits of *Pseudacris streckeri* Wright and Wright in Oklahoma including a description of eggs and tads. The Wasmann Collector **5**(2):47-62.

———1944—Breeding habits, eggs, and tadpoles of *Scaphiopus hurterii*. Copeia **1944**(4):230-241.

——— AND CHARLES CLINTON SMITH. 1942—Observations on the ecology and natural history of Anura. IX. Notes on breeding behavior in Oklahoma. Gt. Basin Nat. **3**(2):33-50.

———1943—Observations on the ecology and natural history of Anura. IV. The ecological distribution of toads in Oklahoma. Ecology **24**(3):285-309.

BRANDES, GUSTAVE AND WALTHER SCHOENICHEN. 1901—Die Brutpflege der schwanzlosen Batrachier. Abh. naturf. Ges. Halle **22**:395-461, Stuttgart.

BRANDT, B. B. 1936—The frogs and toads of eastern North Carolina. Copeia **1936**(4):215-223.

BRIMLEY, C. S. 1940-41—Reptiles and amphibians of North Carolina. Amphibians, Part II. The frogs and toads. Carolina Tips **3**(3-7); **4**(1).

CAGLE, FRED R. 1942—Herpetological fauna of Jackson and Union counties, Illinois. Amer. Midl. Nat. **28**(1):164-200.

CAMPBELL, B. 1931—*Rana tarahumarae*, a frog new to the United States. Copeia **1931**(4):164.

———1934—Report on a collection of reptiles and amphibians made in Arizona during the summer of 1933. Occ. Pap. Mus. Zool. U. of Mich. **289**:1-10.

CARR, A. F. 1940—A contribution to the herpetology of Florida. Univ. Fla. Pub. Biol. Sci. **3**(1):1-118.

CUNNINGHAM, J. T. 1912—Reptiles, amphibia, fishes, and lower chordata. Methuen & Co., Ltd., London, England.

DANFORTH, STUART T. 1925—Porto Rican herpetological notes. Copeia (147):76-79.

DECKERT, RICHARD F. 1914—Further notes on the salientia of Jacksonville, Florida. Copeia (9):1-3.

———1915—Further notes on the salientia of Jacksonville, Florida. Copeia (18):3-5.

———1921—Amphibian notes from Dade county, Florida, Copeia (92):20-23.

DICKERSON, MARY C. 1906—The frog book. Doubleday, Page and Co., New York, New York.

DRIVER, ERNEST C. 1936—Observations on *Scaphiopus holbrooki*. Copeia **1936**(1): 67-69.

DUNN, E. R. 1926—Notes on two Cuban frogs. Copeia (157):154-156.

EATON, THEODORE H. 1941—Notes on the life history of *Dendrobates auratus*. Copeia **1941**(2):93-95.

ENGLEHARDT, GEORGE P. 1918—Batrachians from southwestern Utah. Copeia (60): 77-80.

———1925—A note on the breeding of spadefoot toads in southern Arizona. Copeia (149):91-92.

GADOW, HANS. 1923—Amphibia and reptiles. Macmillan and Co. Ltd., London.

GILMORE, R. J. 1924—Notes on the life history and feeding habits of the spadefoot toad of the western plains. Colo. Coll. Pub. (Sci. Ser.) **13**(1):1-12.

GOIN, C. G. AND M. GRAHAM NETTING. 1940—A new gopher frog from the Gulf Coast, with comments upon the *Rana areolata group*. Ann. Carnegie Mus. **28** (8):137-168.

GREEN, N. BAYARD. 1938—The breeding habits of *Pseudacris brachyphona* (Cope) with a description of the eggs and tadpole. Copeia **1938**(2):79-82.

HECHT, MAX K. AND BESSIE L. MATALAS. 1946—A review of middle North American toads of the genus *Microhyla*. Amer. Mus. Novitates (1315):1-21.

KELLOGG, REMINGTON. 1932—Mexican tailless amphibians in the United States National Museum. U. S. Nat. Mus. Bull. **160**, Washington, D. C.

LIVEZEY, R. L. AND A. H. WRIGHT. 1945—Descriptions of four salientian eggs. Amer. Midl. Nat. **34**(3):701-706.

LOGIER, E. B. S. 1932—Some account of the amphibians and reptiles of British Columbia. Trans. Roy. Can. Inst. **18**(2):311-315, 319-324.

LOVERIDGE, ARTHUR. 1945—Reptiles of the Pacific World. The Macmillan Co., New York, New York.

MITTLEMAN, M. B. 1945—The status of *Hyla phaeocrypta*, with notes on its variation. Copeia **1945**(1):31-37.

MULAIK, STANLEY. 1937—Notes on *Leptodactylus labialis*. Copeia **1937**(1):72-73.

——— AND DWIGHT SOLLBERGER. 1938—Notes on the eggs and habits of *Hypopachus cuneus* Cope. Copeia **1938**(2):90-91.

MYERS, GEORGE S. 1930—The status of the southern California toad, *Bufo californicus* (Camp). Proc. Biol. Soc. Wash. **43**:73-78.

———1942—The black toad of Deep Springs Valley, Inyo county, California. Occ. Pap. Mus. Zool., Univ. Mich. (460):1-13.

NIEDEN, F. 1923—Das Tierreich, Anura I. Deuts. zool. Ges. **46**:1-584, Berlin und Leipzig.

———1926—Das Tierreich, Anura II. Deuts. zool. Ges. **49**:1-110, Berlin und Leipzig.

NOBLE, G. K. 1923—The Anderson tree frog. Zoologica **2**(18):413-455.

———1924—Contributions to the herpetology of the Belgian Congo based on the collection of the American Museum Congo expedition, 1909-1915. Bul. Amer. Mus. Nat. Hist. **49**(2):147-347.

———1927—The value of life history data in the study of the evolution of the amphibia. Ann. N. Y. Acad. Sci. **30**:31-128.

———1931—The biology of the amphibia. McGraw-Hill Book Co., New York, New York.

OVERTON, FRANK. 1914—Long Island fauna and flora. III. The frogs and toads. The Mus. Bkln. Inst. Arts & Sci., Sci. Bull. **2**(3).

PACK, HERBERT J. 1920—Eggs of the swamp tree frog. Copeia (77):7.

POPE, PHILIP H. 1919—Some notes on the amphibians of Houston, Texas. Copeia (76):93-98.

ROSE, WALTER. 1929—Veld and Vlei. The Speciality Press of South Africa, Ltd., Wynberg.

SHERWOOD, W. L. 1898—The frogs and toads found in the vicinity of New York City. Proc. Linnaean Soc. N. Y. (10):9-24.

SLATER, J. R. 1939—Description and life-history of a new *Rana* from Washington. Herpetologica **1**:145-149.

SLEVIN, JOSEPH R. 1928—The amphibians of western North America. Occ. Pap. Calif. Acad. Sci. **16**:1-152.

SMITH, HOBART M. 1934—The amphibians of Kansas. Amer. Midl. Nat. **15**(4):377-528.

SNYDER, J. O. 1920—*Scaphiopus* in northern Nevada. Copeia (86):83-84.

STEJNEGER, LEONARD AND THOMAS BARBOUR. 1943—A check list of North American amphibians and reptiles. Bull. Mus. Comp. Zool., Harvard College **92**(1):1-260.

STORER, TRACY I. 1925—A synopsis of the amphibia of California. Univ. Calif. Pub. in Zool. **27**:1-342.

STRECKER, JOHN K. 1910—Studies in North American batrachology. Notes on the robber frog (*Lithodytes latrans* Cope). Trans. Acad. Sci. St. Louis **19**:73-82.

———1910—Notes on the fauna of northwestern Texas. Baylor Univ. Bull. **13** (4 & 5).

———1922—An annotated catalogue of the amphibians and reptiles of Bexar county, Texas. Bul. **4**, Sci. Soc. San Antonio.

———1926—On the habits and variations of *Pseudacris ornata* (Holbrook). Contr. Baylor Univ. Mus. **7**:8-11.

———1926—Chapters from the life histories of Texas reptiles and amphibians. Part I. Contr. Baylor Univ. Mus. **8**:1-12.

SVIHLA, ARTHUR. 1935—Notes on the western spotted frog, *Rana p. pretiosa*. Copeia **1935**(3):119-122.

TROWBRIDGE, A. H. 1937—Notes on the cleavage rate of *Scaphiopus bombifrons* Cope, with additional remarks on certain aspects of its life history. Amer. Nat. **71** (736):460-480.

WALKER, C. F. 1932—*Pseudacris brachyphona* (Cope), a valid species. Ohio Jour. Sci. **32**(4):379-384.

WRIGHT, A. A. AND A. H. WRIGHT. 1942—Handbook of frogs and toads. Comstock Pub. Co., Inc., Ithaca, N. Y.

WRIGHT, A. H. 1914—Life histories of the anura of Ithaca, New York. Carnegie Inst. Wash. Pub. **197**.

———1920—Frogs; their natural history and utilization. Bureau of Fisheries Documents **888**:1-40.

———1923—The salientia of the Okefinokee Swamp, Georgia. Copeia (115):34.

———1929—Synopsis and descriptions of North American tadpoles. Proc. U. S. Nat. Mus. **74**(2756), Art. 11: 1-70.

———1931—Life histories of the frogs of Okefinokee Swamp, Georgia. The Macmillan Co., New York, New York.

——— AND A. A. WRIGHT. 1924—A key to the eggs of the salientia east of the Mississippi river. Amer. Nat. **58**(657):375-381.

——— AND ———1936—Contributions to North American herpetology. The frogs. Unpublished manuscript, 3 vols.

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Table of Equivalent Populations of North American Small Mammals

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Introduction

During 1943, 110 titles concerning population densities and home ranges of about 60 species of North American small mammals, covering most of the titles on the subject through 1941, were summarized by the writer. Because many such studies seemed to have been designed for eventual comparison and could each therefore profit by being fitted into its proper place in a scale, that summary was intended to compare methods and results of censuses and to draw such conclusions about comparative populations as seemed warranted by the diversity of census methods used.

Based upon apparent intent and purpose, censuses fall into the following groups:

A. Those intended to discover the population on some given area, the chief interest being in the number of individuals at hand, but not the area or their relationship to the area.

B. Those intended to discover the population on a given area of apparently uniform type of vegetable, cover, soil, etc. the purpose being either (1) to estimate the number of individuals at hand by means of a convenient breakdown of the area by habitat types or, (2) to obtain a general ecological picture of the cover type in question.

C. Those intended to discover the number of individuals in areas which they actually occupy during the census period, or, in other words, economic densities as defined by Elton, 1932.

Censuses A and B are commonly used by game managers and forest and preserve supervisors. Class B is commonly used by ecologists.

Class A rarely contributes much to a fundamental study of populations; Class B frequently affords useful sidelights because it sometimes happens that given uniform cover types are quite uniformly inhabited, hence without large blanks. Class C, by its nature, eliminates blanks to the extent permitted by the methods used and hence contributes directly to studies of economics densities of mammals. (*See* Elton 1932 for definition of economic density.)

In Table 1, economic densities or near-economic densities of mammals are compared conveniently by means of total weights of mammals of a given species per acre, the data being from the writer's 1943 paper. Certain papers published since 1941 are discussed and data tabulated herein. Authorities are those listed in the 1943 paper or in the present paper.

TABLE 1

Species	Number per acre	Authority	Individual weight	Grams per acre	Duration of census
Didelphis virginiana	0.330	Yeager (1937)	2724.00	900	1.5 months.
Didelphis virginiana	.250	Lay (1942)	2724.00	680	4 months.
Didelphis virginiana	.070	Lay (1942)	2724.00	190	Instant.
Parascalops breweri	1.000	Bole (1939)	50.00	50	3 days.
Parascalops breweri	4.000	Bole (1939)	50.00	205	3 days.
Parascalops breweri	24.000	Bole (1939)	50.00	1225	3 days.
Condylura cristata	6.000	Bole (1939)	52.00	310	3 days.
Condylura cristata	10.000	Hamilton (1931)	52.00	520	Instant.
Condylura cristata	17.000	Hamilton (1931)	52.00	880	Instant.
Sorex cinereus	5.000	Bole (1939)	4.13	20	3 days.
Sorex cinereus	11.000	Bole (1939)	4.13	45	3 days.
Sorex fumeus	5.000	Bole (1939)	8.14	40	3 days.
Sorex fumeus	10.000	Bole (1939)	8.14	80	3 days.
Sorex fumeus	25.000	Hamilton (1940)	8.14	205	3 days.
Sorex fumeus	50.000	Hamilton (1940)	8.14	410	3 days.
Sorex fumeus	58.000	Bole (1939)	8.14	470	3 days.
Blarina brevicauda	4.000	Shull (1907)	20.00	80	Instant.
Blarina brevicauda	8.000	Mamilton (1931)	20.00	160	Instant.
Blarina brevicauda	50.000	Seton (1909)	20.00	1000	Instant.
Blarina brevicauda	48.000	Bole (1939)	20.00	960	Instant.
Procyon lotor	.160	Yeager (1937)	7264.00	1160	1.5 months.
Mustela frenata	.360	P. K. & H. (1941)	165.00	60	Several months.
Mustela frenata	.100	P. K. & H. (1941)	165.00	15	Several months.
Mustela frenata	.170	P. K. & H. (1941)	165.00	30	Several months.
Mustela vison	.014	Marshall (1936)	908.00	50	Several days.
Mephistis mephitis	.130	Hamilton (1936)	2586.00	225	Instant.
Mephistis mephitis	.100	Hamilton (1936)	2586.00	210	Instant.
Mephistis mephitis	.900	Allen (1939)	2586.00	230	Instant.

Mephistis mephitis	.140	S. & S. (1939)	2586.00	285	Instant.
Mephistis mephitis	.070	S. & S. (1939)	2586.00	180	Instant.
Taxidea taxus	.002	Seton (1929)	13620.00	25	Instant.
Vulpes fulva	.005	G. D. & L. (1937)	5448.00	10	Instant.
Vulpes fulva	.005	Scott (1943)	5448.00	30	10 months.
Vulpes fulva	.006	Scott (1943)	5448.00	30	7 months.
Urocyon cin'argenteus	.009	Errington (1933)	4500.00	40	Winter months.
Canis latrans	.001	Edge (1935)	15890.00	15	Instant.
Canis latrans	.003	Comegys (1904)	15890.00	50	Drive.
Marmota monax	.200	Seton (1929)	4540.00	1135	Instant.
Marmota monax	3.000	Seton (1929)	4540.00	13620	Summer months.
Marmota monax	5.000	Hamilton (1934)	4540.00	22700	Instant.
Citellus lateralis	4.000	Gordon (1938)	187.00	750	Instant.
Citellus lateralis	2.500	Gordon (1938)	187.00	470	Instant.
Citellus beecheyi	5.000	Horn (1938)	635.00	3175	Instant.
Citellus beecheyi	16.000	Horn (1938)	635.00	3810	Instant.
Citellus beecheyi	10.000	Horn (1938)	635.00	6350	Instant.
Citellus beecheyi	20.000	Horn (1938)	635.00	12700	Instant.
Citellus beecheyi	25.000	Horn (1938)	635.00	15875	Instant.
Citellus columbianus	25.000	Shaw (1920)	454.00	3400	Instant.
Citellus richardsoni	10.000	Seton (1929)	340.00	8500	Instant.
Citellus richardsoni	25.000	Seton (1929)	340.00	10200	Instant.
Citellus richardsoni	30.000	Seton (1929)	340.00	10700	Instant.
Citellus richardsoni	50.000	Seton (1929)	340.00	28815	Instant.
Citellus townsendii	113.000	Couch (1928)	255.00	49940	Instant.
Citellus b. oregonus	110.000	Grinnell (1919)	454.00	9650	Instant.
Citellus 13-lineatus	50.000	Kennicott (1855)	193.00	19300	Instant.
Citellus 13-lineatus	100.000	Kennicott (1855)	193.00	350	Instant.
Citellus 13-lineatus	3.500	Wooster (1939)	100.00	28375	Instant.
Cynomys ludovicianus	25.000	Merriam (1901)	1135.00	18975	Instant.
Cynomys g. zuniensis	25.000	T. & L. (1924)	759.00	170	Instant.
Tamias striatus	2.000	Seton (1929)	85.00	1190	Instant.
Tamias striatus	14.000	Seton (1929)	85.00	1700	Instant.
Tamias striatus	20.000	Seton (1929)	85.00	2550	Instant.
Tamias striatus	30.000	Seton (1929)	85.00	70	Several weeks.

TABLE 1—(Continued).

Species	Number per acre	Authority	Individual weight	Grams per acre	Duration of census
Tamias striatus	.800	Burt (1940)	85.00	305	Several weeks.
Tamias striatus	3.600	Burt (1940)	85.00	2290	Instant.
Tamiasciurus hudsonicus	9.000	D. & S. (1922)	254.00	255	Instant.
Tamiasciurus hudsonicus	1.000	D. & S. (1922)	254.00	510	Instant.
Tamiasciurus hudsonicus	2.000	D .& S. (1922)	254.00	760	Instant.
Tamiasciurus hudsonicus	3.000	D. & S. (1922)	254.00	1780	Instant.
Tamiasciurus hudsonicus	7.000	D. & S. (1922)	254.00	2290	Instant.
Tamiasciurus hudsonicus	9.000	D. & S. (1922)	254.00	65	Instant.
Tamiasciurus hudsonicus	.250	Hornaday (1913)	254.00	55	Instant.
Tamiasciurus hudsonicus	.220	Hatt (1929)	254.00	245	Instant.
Tamiasciurus hudsonicus	1.000	Hatt (1929)	254.00	171	Instant.
Tamiasciurus hudsonicus	.700	Hatt (1929)	254.00	80	Instant.
Tamiasciurus hudsonicus	.330	Hatt (1929)	254.00	80	Instant.
Tamiasciurus hudsonicus	.340	Baumgartner (1938)	254.00	1500	Instant.
Sciurus carolinensis	3.000	Seton (1920)	500.00	1000	Instant.
Sciurus carolinensis	2.000	Goodrum (1937)	500.00	400	Instant.
Sciurus carolinensis	.800	Goodrum (1937)	500.00	100	Instant.
Sciurus carolinensis	.500	Goodrum (1937)	500.00	700	Instant.
Sciurus carolinensis	1.400	Goodrum (1937)	500.00	450	Instant.
Sciurus carolinensis	.900	Goodrum (1937)	500.00	350	Instant.
Sciurus carolinensis	.700	Goodrum (1937)	500.00	350	Summer months.
Sciurus carolinensis	.700	Chapman (1938)	500.00	100	Summer months.
Sciurus carolinensis	.200	Chapman (1938)	500.00	165	Summer months.
Sciurus carolinensis	.300	Chapman (1938)	500.00	150	Summer months.
Sciurus niger	.700	Baumgartner (1938)	814.00	570	Summer months.
Sciurus niger	.800	Baumgartner (1938)	814.00	650	Summer months.
Sciurus niger	5.000	Seton (1929)	814.00	4070	Summer months.
Sciurus niger	2.000	Allen (1938)	814.00	1630	Winter months.

Sciurus niger	.500	B. & N. (1937)	814.00	165	Instant.
Glaucomys volans	5.000	Seton (1929)	55.00	275	Instant.
Glaucomys volans	1.300	Burt (1940)	55.00	71	6 weeks.
Glaucomys volans	1.600	Burt (1940)	55.00	90	6 weeks.
Thomomys talpoides	2.000	Seton (1929)	140.00	280	Instant.
Thomomys talpoides	3.000	Seton (1929)	140.00	420	Instant.
Thomomys talpoides	5.000	Seton (1929)	140.00	700	Instant.
Thomomys talpoides	10.000	Seton (1929)	140.00	1400	Instant.
Geomus bursarius	3.000	Bailey (1895)	350.00	1050	Instant.
Geomus bursarius	4.000	Bailey (1895)	350.00	1420	Instant.
Geomus bursarius	10.000	Butcher (1921)	350.00	3500	Instant.
Geomus bursarius	15.000	Butcher (1921)	350.00	5250	Instant.
Geomus bursarius	4.000	M. & M. (1936)	350.00	1420	Instant.
Geomus bursarius	4.500	M. & M. (1936)	350.00	1580	Instant.
Dipodomys spectabilis	.700	M. & K. (1940)	115.00	80	Instant.
Dipodomys spectabilis	2.400	V. & T. (1922)	115.00	275	Instant.
Dipodomys spectabilis	2.000	Taylor (1930)	115.00	230	Instant.
Dipodomys spectabilis	1.500	Calahane (1941)	115.00	170	3 days.
Dipodomys merriami	2.000	M. & K. (1940)	45.00	90	Instant
Dipodomys merriami	12.000	M. & K .(1940)	45.00	540	Instant.
Erethizon dorsatum	.080	Struthers (1928)	7582.00	605	Days.
Erethizon dorsatum	.040	Seton (1929)	7582.00	305	Instant.
Peromyscus maniculatus	5.300	Blair (1940)	16.00	85	Weeks.
Peromyscus maniculatus	16.000	Blair (1940)	16.00	155	Weeks.
Peromyscus maniculatus	12.000	Blair (1940)	16.00	190	Weeks.
Peromyscus maniculatus	2.700	Wooster (1939)	16.00	45	Weeks.
Peromyscus leucopus	5.000	Burt (1940)	22.00	110	2+ months.
Peromyscus leucopus	7.400	Burt (1940)	22.00	165	1 month.
Peromyscus leucopus	7.200	Burt (1940)	22.00	160	1.5 months.
Sigmodon hispidus	40.000	Stoddard (1932)	170.00	6720	Instant.
Neotoma albigula	2.400	M. & K. (1940)	197.00	480	Months.
Neotoma albigula	1.200	Calahane (1941)	197.00	240	Days.
Neotoma albigula	2.300	Calahane (1941)	197.00	460	Days.
Neotoma albigula	20.000	S. & S. (1941)	197.00	3980	Days.
Synaptomys cooperi	14.000	Stegeman (1930)	22.00	310	Days.

TABLE 1—(Continued).

Species	Number per acre	Authority	Individual weight	Grams per acre	Duration of census
Microtus pennsylvanicus	40.000	Blair (1940)	.20	10	Days.
Microtus pennsylvanicus	40.000	Blair (1940)	.60	25	Days.
Microtus pennsylvanicus	40.000	Blair (1940)	.80	30	Days.
Microtus pennsylvanicus	40.000	Blair (1940)	1.20	48	Days.
Microtus pennsylvanicus	40.000	Blair (1940)	2.20	88	Days.
Microtus pennsylvanicus	40.000	Blair (1940)	2.20	88	Days.
Microtus pennsylvanicus	40.000	Blair (1940)	2.60	105	Days.
Microtus pennsylvanicus	40.000	Blair (1940)	3.50	140	Days.
Microtus pennsylvanicus	40.000	Blair (1940)	5.80	230	Days.
Microtus pennsylvanicus	40.000	Hamilton (1937)	8.00	320	Instant.
Microtus pennsylvanicus	40.000	Blair (1940)	8.50	340	Days.
Microtus pennsylvanicus	40.000	Blair (1940)	9.20	370	Days.
Microtus pennsylvanicus	40.000	Blair (1940)	9.20	370	Days.
Microtus pennsylvanicus	40.000	Blair (1940)	10.00	400	Days.
Microtus pennsylvanicus	40.000	Blair (1940)	11.90	480	Days.
Microtus pennsylvanicus	40.000	Hamilton (1937)	12.00	480	Days.
Microtus pennsylvanicus	40.000	Hamilton (1937)	12.00	480	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	13.00	520	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	15.00	600	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	20.00	800	Instant.
Microtus pennsylvanicus	25.000	Hamilton (1937)	25.00	1000	Instant.
Microtus pennsylvanicus	25.000	Hamilton (1937)	25.00	1000	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	30.00	1200	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	35.00	1400	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	35.00	1400	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	40.00	1600	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	40.00	1600	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	40.00	1600	Instant.

Microtus pennsylvanicus	40.000	Hamilton (1937)	50.00	2200	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	50.00	2200	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	55.00	2200	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	55.00	2200	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	60.00	2400	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	60.00	2400	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	60.00	2400	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	70.00	2800	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	70.00	2800	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	75.00	3000	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	80.00	3200	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	80.00	3200	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	90.00	3600	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	100.00	4000	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	110.00	4400	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	120.00	4800	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	140.00	5600	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	155.00	6200	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	225.00	9000	Instant.
Microtus pennsylvanicus	40.000	Hamilton (1937)	240.00	9600	Instant.
Microtus montanus	200.000	Piper (1909)	50.40	10040	Instant.
Microtus montanus	500.000	Piper (1909)	50.40	27200	Instant.
Microtus montanus	800.000	Piper (1909)	50.40	40320	Instant.
Pitymys pinetorum	4.000	Bole (1939)	27.50	110	3 days.
Pitymys pinetorum	6.000	Bole (1939)	27.50	145	3 days.
Pitymys pinetorum	8.000	Bole (1939)	27.50	220	3 days.
Pitymys pinetorum	18.000	Bole (1939)	27.50	495	3 days.
Pitymys pinetorum	200.000	Hamilton (1938)	27.50	5500	Instant.
Pitymys pinetorum	225.000	Hamilton (1938)	27.50	6190	Instant.
Pitymys pinetorum	300.000	Hamilton (1938)	27.50	8250	Instant.
Ondatra zibethica	10.000	Johnson (1925)	918.00	9180	Instant.
Ondatra zibethica	12.000	Johnson (1925)	918.00	11015	Instant.
Ondatra zibethica	20.000	Johnson (1925)	918.00	18360	Instant.
Ondatra zibethica	5.000	Errington (1938)	918.00	4590	Instant.
Ondatra zibethica	3.000	Errington (1938)	918.00	2754	Instant.

TABLE 1—(Continued).

Species	Number per acre	Authority	Individual weight	Grams per acre	Duration of census
Ondatra zibethica	26.000	Butler (1940)	918.00	23830	Instant.
Ondatra zibethica	10.000	Errington (1940)	918.00	9180	Instant.
Ondatra zibethica	1.000	Errington (1940)	918.00	918	Instant.
Mus musculus	2099.000	Hall (1927)	13.60	28555	Instant.
Mus musculus	968.000	Hall (1927)	13.60	13175	Instant.
Mus musculus	242.000	Hall (1927)	13.60	3290	Instant.
Zapus hudsonius	5.000	Blair (1940)	14.50	70	Weeks.
Zapus hudsonius	3.400	Blair (1940)	14.50	50	Weeks.
Zapus hudsonius	4.300	Blair (1940)	14.50	60	Weeks.
Zapus hudsonius	4.000	Blair (1940)	14.50	60	Weeks.
Zapus hudsonius	2.200	Blair (1940)	14.50	45	Weeks.
Zapus hudsonius	1.400	Blair (1940)	14.50	20	Weeks.
Zapus hudsonius	2.600	Blair (1940)	14.50	40	Weeks.
Lepus townsendii	.120	M. & M. (1936)	3292.00	310	Instant.
Lepus townsendii	.020	M. & M. (1936)	3292.00	50	Instant.
Lepus alleni	.130	V. & T.(1933)	3632.00	750	Instant.
Lepus californicus	.640	Wooster (1935)	3039.00	1945	Instant.
Lepus californicus	.770	Wooster (1935)	3039.00	2340	Instant.
Lepus californicus	.250	Wooster (1935)	3039.00	760	Instant.
Lepus californicus	.300	Wooster (1935)	3039.00	910	Instant.
Lepus californicus	.640	Wooster (1935)	3039.00	1945	Instant.
Lepus californicus	.770	Wooster (1935)	3039.00	2340	Instant.
Lepus californicus	.290	Wooster (1935)	3039.00	880	Instant.
Lepus americanus	16.000	Seton (1929)	1543.00	24690	Instant.
Lepus americanus	.430	G. & S. (1934)	1543.00	665	Instant.
Lepus americanus	.670	G. & S. (1934)	1543.00	1035	Instant.
Lepus americanus	.750	G. & S. (1934)	1543.00	1160	Instant.
Lepus americanus	.510	G. & S. (1934)	1543.00	790	Instant.

Lepus americanus	.900	G. & S. (1934)	1543.00	1310	Instant.
Lepus americanus	.390	Morse (1939)	1543.00	615	Instant.
Lepus americanus	.780	G. L. & B. (1939)	1543.00	1205	Instant.
Sylvilagus t. mearnsi	.250	D. & S. (1936)	1580.00	395	1+ year.
Sylvilagus t. mearnsi	.330	D. & S. (1936)	1580.00	520	1+ year.
Sylvilagus t. mearnsi	4.000	Hendrickson (1941)	1580.00	6320	Instant.
Sylvilagus t. mearnsi	.900	Leopold (1933)	1580.00	1420	Months.
Sylvilagus t. mearnsi	3.500	Allen (1939)	1580.00	5530	Months.
Sylvilagus t. mearnsi	.500	Allen (1939)	1580.00	790	Months.
Sylvilagus t. mearnsi	.060	Haugen (1942)	1580.00	95	4 months.?
Sylvilagus t. mearnsi	.100	Haugen (1942)	1433.00	145	4 months.?
Dasypus n. texanus	.100	Lay (1942)	5313.00	530	Instant.
Dasypus n. texanus	.820	Kalmbach (1943)	5313.00	4355	Instant.
Dasypus n. texanus	.230	Kalmbach (1943)	5313.00	1210	Instant.
Dasypus n. texanus	.210	Kalmbach (1943)	5313.00	1115	Instant.

Discussion of Papers Published Since 1941

Primarily Carnivorous Species

RED FOX, *Vulpes fulva regalis* Merriam.

Scott, in 1943 trailed an Iowa red fox, probably a female, in unusually good tracking snow in December. By following the outermost tracks he traced out all of the area over which she had hunted and found that her 24 hour activity range was approximately 25 acres. If she weighed approximately 12 pounds (5,448 grams) her 24-hour range* factor is about 220.

Primarily Insectivorous Species

ARMADILLO, *Dasypus novemcinctus texanus* Bailey.

Lay, 1942, excavated "all dens found on measured four-acre sample plots" on 102 acres of sandy Texas coastal prairie, finding 10 armadillos or a population of one armadillo to 10 acres. This is an instantaneous or momentary population density, that is, it represents a population at a particular moment or point of time in contrast to moving population densities which are complicated by changes in numbers of individuals over long census periods.

Weights of three males, 13, 12 and 13 pounds, and 3 females, 8, 11 and 13 pounds, recorded by Kalmbach, 1943, indicate that the average armadillo may weigh about 11.7 pounds or 5,313 grams. The momentary weight factor per acre is therefore about 530 grams.

Kalmbach, 1943, records the density of armadillos as being 0.82 per acre, 0.23 per acre and 0.21 per acre, yielding factors of from about 4,355 down to 1,115. His manner of citing those populations indicates that they are of the momentary type rather than based on census periods of long duration.

Whether one or all of these concentrations are economic, cannot be gauged from the data but all show levels which armadiollo populations do attain. They are relatively high as compared with many other species.

Taber, 1945, found as many as two to the acre and one per three acres giving a per-acre weight of 10,625 if the armadillos were near average size.

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*Home range according to Burt, 1943, is the area, usually around a home site, over which an animal normally travels in search of food. Occasional sallies outside of the home area and movement from one home site with surrounding home range to another should not be considered part of the home range. Animals frequently have different home ranges at different seasons and during the course of their lives.

Haugen found that by live-trapping cottontails approximately 12 times, the full extent of their normal travels, hence their home range, was revealed. Blair found that more captures were required for woodland deermice.

Home territory according to Burt, is that part of the home range which is actively protected against encroachment by other members of the species.

The present writer believes that periodic range studies, (i.e., 24-hour range, 2-day range, weekly range, etc.), should be designated in addition and in contradistinction to home range.

Primarily Omnivorous Species

OPOSSUM, *Didelphis virginiana virginiana*, Kerr.

Lay, 1942, working in Texas, live-trapped, marked, released and retrapped opossums on 86 acres of poorly drained coastal pine and hardwood stand which had not been disturbed by cutting for 20 years. This area had a more abundant and varied opossum food supply than most pine woodland but scarcity of water during dry periods probably caused the animals to move about considerably. Twenty-nine live traps, or stations, were set in irregular patterns rather than arranged in grid pattern, probably so as to locate them in a likely spot for successful trapping.

Home Range.—Home range calculations were based on data furnished by 29 opossums which were caught at three or more stations, the minimum range being estimated by calculating the area enclosed by imaginary lines connecting the outermost stations visited by the individual in question as, indicated in fig. 1A.

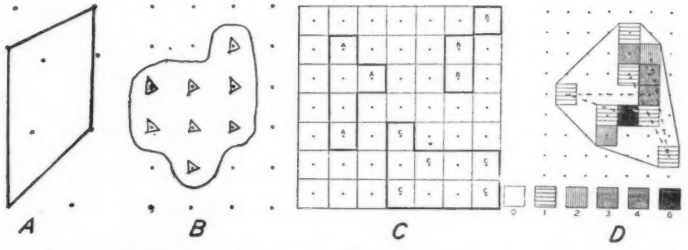

Fig. 1.—Methods of Delimiting Supposed Home Range.—A. Dalke's 1938 method, B. Burt's 1940 method, C. Haugen's 1942 method, D. Blair's 1942 method. Dots indicate position of traps. Outlines show the supposed outer limits of the home range of the animal in question. Trap-positions with letters, surrounded by triangles or enclosed in shaded grids are those in which animals were caught. Dalke's method has been called the minimum home range method. Others are modifications of the grid method. Blair's method stresses the number of times an animal is caught in each grid, which, in the case of the example was from 0 to 6 times.

Extremes so measured, varied from about one-third acre to 58 acres. The mean minimum home range was 11.5 acres. The HRF (home-range factor), assuming the opossums to weigh 2,724 grams (6 lbs.) is 240 for the mean home range of 11.5 acres, that mean derived from varying periods of observation of 29 individuals, the longest period of observation of a single individual being somewhat over 11 months and the shortest shown in the study only 4 months with a mean minimum period of perhaps 8 months.

One female, taken 48 times at 11 stations during a nine-month period beginning January 26, maintained a home range of approximately 11.5 acres after having moved around considerably between the second and third times caught as calculated from the map accompanying Lay's text. Another female,

caught 30 times at 13 stations during approximately eight months, beginning May 31, maintained a home range of about 39 acres. A male which was caught 29 times at seven stations during almost four months from March 14, maintained a home range of approximately 22 acres. The HRF for these individual cases varied from approximately 60 during 8 months to 210 in nine months.

Effect of Size of Grid on Home Range Estimates.—It is of interest to compare the result obtained by estimating the area enclosed by imaginary lines connecting outlying points, i.e., the minimum home-range method, (Fig. 1A) and that of using grids or quadrants of various sizes. Fig. 1C and 1D. This provides profitable examination because such widely diverse methods are actually in use, each purporting to be more or less correct and often erroneously used as a basis of comparing home ranges of various species.

TABLE 2.—Estimated Home Range (Acres).

Animal No.	Minimum HR	HR Based on 1-Acre grids	HR Based on 4-Acre grids	HR Based on 16-Acre grids
19 (HR complete)*	38.4	58	64	64
44	39.0	42	52	64
19 (HR terminal)	11.5	13	20	32
29	22.0	30	32	48

*In the case of Lay's animal No. 19 two HR estimates are afforded due to nature of activity of the animal. These are referred to as "complete" and "terminal."

Reference to Table 2 shows that the grid system superimposed on Lay's range map gives the larger HR (home range) estimate and that in spite of irregularities, to be explained later, the larger a grid, the larger the resulting estimate.

The relative size of grid and resulting size of HR estimate are shown below, in terms of percentage of the minimum home-range estimate.

TABLE 3.—Size of Grid as Compared with Minimum HR.

Size of grid as compared with minimum HR (percent)	2.5	2.6	4.5	8.6	10.3	10.4	18	35	41	42	73	139
Size of estimated HR with reference to minimum HR (percent)	108	151	136	113	133	167	145	174	164	167	218	278

In Table 3, where the grid is 2.5 percent of the minimum HR, the resulting HR estimate is 108 percent of the minimum HR. With some irregularities there is a positive correspondence between the size of the grid and the size of the HR estimate to a point where, when the grid is 139 percent of the minimum HR, the HR estimate based on that grid is 278 percent of the minimum HR.

It is apparent that to a certain degree, the smaller the grid used either in trapping or in calculating HR, the more nearly accurate will be the HR esti-

mate. In the case of the opossum even a grid which is only 2.6 percent of the minimum HR may be too large because it gives an estimated HR as high as 151 percent of the minimum HR.

Effect of Shape of Home Range on Differences Between Grid and Minimum Home Range Estimates.—Examination of irregularities mentioned for the above correlation will be profitable. These irregularities are due in part to the *shape* of the minimum home range. Where it is relatively compact, that is approaching a circle in general shape, the variation is not as great as where the minimum HR is more elongate. See Table 4 in which home ranges are arranged in order from the most elongate to the most compact.

TABLE 4

Shape of minimum HR from elongate to compact	Size of grid (acres)	Estimated minimum HR	Percent of deviation of grid HR from minimum HR
No. 19 (final)	1	11.5	8.6
No. 29	1	22	4.5
No. 19 (complete)	1	38	2.6
No. 44	1	39	2.5

The same correlation demonstrated above for one-acre grids holds true for four- and sixteeen-acre grids, hence need not be tabulated.

It appears therefore that minimum HR estimates are more fundamentally comparable between species and individuals than any estimate based upon grids, unless possibly the grids used are very small as compared with the minimum HR. This is further demonstrated in the discussion of cottontails in following pages.

Effect of Shape of Home Range and Size of Grids on Estimates.—In Fig. 2A the diagrammatic home range occupies about 0.75 acre. The estimated home range based on one-acre grids is two acres or about two and one-half times the true range. In Fig. 2C the home range is about one acre, whereas the estimated range is twice as large. These results show why a less compact home range such as 2A is likely to be overestimated to a greater degree than is a compact home range when a grid system is used.

If the home range in Figure 2A had been long enough almost to include three traps in any direction the difference between true size and estimated size would have been less than in the illustration above but would still be very large.

In Fig. 2B the true range is over four acres whereas the estimated range is four acres. In this case the real range is larger than the estimated home range. This illustrates why a large home range is less likely to be overestimated than a large small range. That such great variation actually occurs due to the reasons illustrated is shown in discussion of individual animals below, especially for the opossum and rabbit.

Those home range estimates discussed under individual animals were based uniformly on grids which were too large in relation to the real home range.

These facts indicate that the large grid system gives such variable answers that estimates of home range based upon it cannot be used accurately in comparing home ranges between two species.

A small grid system is more likely to give a correct estimate.

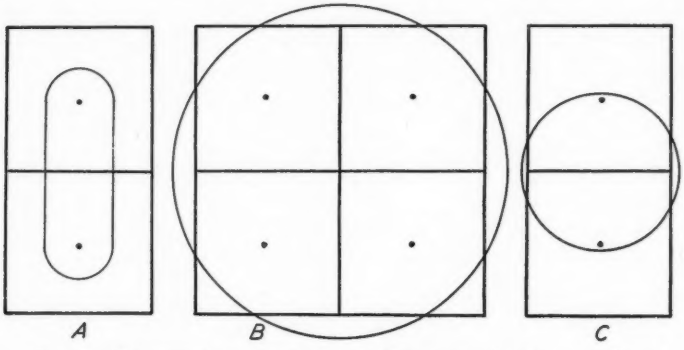

Fig. 2.—Diagrammatic representation of home ranges (circles or oval) and relation to estimated home range based on one-acre grids. Dots represent traps in which animal may have been caught.

Population Density.—Lay estimated population densities of possums on the 86-acre woodland by quarters. From January 1 through March, he caught 18 possums one year and 17 the following year; from the 1st of April through June he caught 36 and 18; from the 1st of July through September he caught 24 one year and 19 the next; and from the 1st of October through December of one year he caught 16.

An average of 8.8 animals was caught more than once during each three months period but Lay believed that more than that were resident on the area because some individuals which were not caught more than once during one quarter, were caught several times during the following quarter.

Trapping on five 16-acre quadrats during October and September each with 24 steel traps baited with a fish scent, produced from one to four oppossums the first night. Catches during second and third nights suggested that few resident opossums escape the first night but that one cannot tell sufficiently well how many of the possums on such small quadrats are migrants from surrounding areas. Lay concluded from these experiments that the population density in favorable habitats approaches one possum to four acres, which gives a density factor of about 680 or almost three times as great as the HRF.

The population density of possums on 102 acres of sandy coastal prairie in February was one to 14.6 acres, as determined "by excavation of all dens found on measured 4-acre sample plots."

This was a momentary population, that is, one achieved in such a short

period of time and in such a manner as to avoid change in the population while the census was being made. That not all of the 102 acres was inhabited by opossums was indicated by the fact that distribution of used dens showed a close correlation with thickets of blackberry and myrtle bushes. The density factor is about 190.

Yeager, 1937, reviewed by Mohr, 1943, caught an average of one opossum per three acres of favorable habitat during approximately a month and a half from November 15. The 1.5 months density factor for one possum per three acres is about 905 or very close to that estimated from Lay's data. Yeager thought that there might even be one possum per two acres on the area which he trapped.

STRIPED SKUNK, *Mephitis mephitis* (Schr.).

Lay, 1942, excavated all dens on measured 4-acre sample plots on 102 acres of sandy Texas prairie during February, turning up 8 striped skunks, or an average of one per 13 acres. This figure is close to the 10-to-12 acres-per-skunk estimate of Hamilton, 1936, in a 100-acre New York orchard during "spring;" close also to one skunk per 11 acres estimated by Allen, 1937, 1938 and 1940, summarized by Mohr, 1943, all probably economic densities. It is slightly lower than the economic density of 7-acres-per-skunk estimate of Scott and Selko, 1939, as the breeding season population in Iowa, when of course, larger concentrations are to be expected.

SPOTTED SKUNK, *Spilogale putorius* (Linn.).

Lay, 1942, found the concentration of spotted skunks on Texas prairie to be about one per 51 acres. Without much doubt this is a sub-economic density.

Primarily Herbivorous Species

MISSISSIPPI VALLEY POCKET GOPHER, *Geomys bursarius bursarius* Shaw.

Scheffer, 1940, studied the home range of a single pocket gopher in such a way as to provide most a revealing sidelight on possible home range of other mammals whose activities are not revealed so clearly by the trapping method. Figure 3, partially from Scheffer's paper is reproduced for study.

Comparison Between Real Use of Area and Use as Might be Interpreted by Grid and Other Systems.—The gopher had a runway in more or less active use, approximating 510 feet in length and 2.75 inches in width. Its entire area was therefore 117 square feet or about 0.003 acres.

That was all the territory which this individual was actively using.

What a grid method of determining its supposed home range might reveal, can be pictured by imagining a system of grids superimposed on the figure of the runway. What a minimum home range method might reveal is indicated by the outline which the present writer has drawn around the runway.

It is apparent that each would yield results far different from the truth and that the yield of one would be entirely different from the yield of the other, hence be in no way comparable.

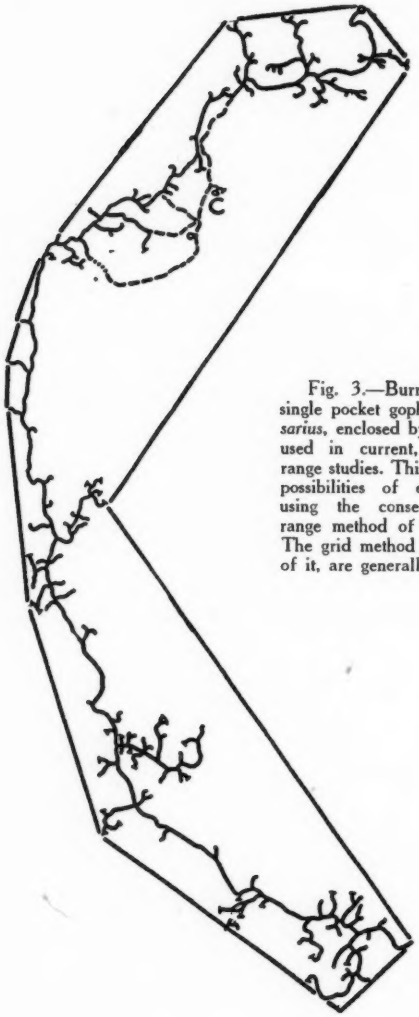

Fig. 3.—Burrow system of a single pocket gopher, *Geomys bursarius*, enclosed by straight lines as used in current, minimum home range studies. This reveals the wide possibilities of error even when using the conservative minimum range method of estimating range. The grid method and modifications of it, are generally less accurate.

It is most likely that activities of many other mammals are similar to this. Meadowmice and shrews for example have a surface runway system very similar to this.

Obscure Areal Requirements to be Solved.—We may profitably examine other details about the home range of the pocket gopher in question. It is evident that she must have certain other range requirements than a mere 0.003 acres.

Scheffer mentioned that her system of runways was isolated by 15 to 20 rods from any other gopher workings. Furthermore the highest estimate of gopher populations published is one of 15 per acre in ideal gopher forage such as clover and alfalfa. If these individuals averaged 0.003 acres of runway, their total usage would amount to only 0.045 acres. Plainly then much of the remainder and perhaps all of the acreage not actively occupied was also part of their required range.

If so, the various regions or subdivisions of that range might be named for clarity's sake. Probably the 0.003 acres actually occupied by the runway is equivalent to home territtory as defined by Burt. There is also outside of the walls of the tunnel a certain amount of area through which such solitude-requiring mammals as gophers can detect too near presence of other individuals which they will make all effort to repel at certain seasons. This too is part of the home territory.

Some of the remaining excess area may be referred to as "resting area" because in any gopher colony may be found old mounds and old runway systems more or less depleted of surrounding food and possibly also repellent to gophers because of previous habitation. Such resting area gradually becomes restored and usable. It is relatively extensive and long-lasting on relatively sterile ground.

Beyond the combined home territory and resting areas lay other areas which, to judge by their presence on even highly populated ground, are essential to the wellbeing of gophers. These may possibly be equivalent to home range as defined by Burt, although we neither have proof that they qualify under his definition nor knowledge of the reason and mechanism by which they exist. The questions are then: Can this be included as part of the home range and if so, do other mammals have areas similar in functions which must be recognized in future studies.

COTTONTAIL RABBIT, *Sylvilagus floridanus mearnsii* Merriam.

Haugen, 1942a, determined the home range of cottontails in sandy upland areas in southwestern Michigan. He used 294 live traps, 49 on each of six 160-acre areas, locating the traps at approximately 110-yard intervals with the outermost traps 110 yards inside the border of the areas. Each trap was therefore surrounded by a square of 2.5 acres which was taken to represent a portion of the home range of any rabbit caught in that trap.

A combination of plain ear corn, corn soaked for two or three days in salt solution, rolled oats and apples proved to be attractive bait at all seasons.

Tracking in snow and observation of seats colored by feeding dye to the rabbits supplemented trapping records.

Home Range.—Haugen concluded that home range requirements of female cottontails in sandy upland areas were 22.5 acres during the breeding season. Since females averaged 1,463 grams during this period, a HRF of 65 is implied. The length of occupancy of this range was not given but the year was descriptively divided into breeding season, fall and winter which indicates a 4-month period.

During fall the home range of adult females was slightly over 15 acres and the average weight 1,457 grams. A HRF of approximately 100 is implied for perhaps 4 months.

During winter the home range was 14 acres and the weight 1,360 grams. The HRF was therefore again about 100 for this 4-month period.

Adult males roamed over an area of probably 100 acres or more during the breeding season. The male HRF is about 15, presumably for a 4-month period.

Average Population Density.—The breeding population on the sandy upland studied by Haugen, consisted of about one rabbit to 17 acres. Males weighing 1,463 grams and females 1,696 grams and the sex ratio being nearly equal, a population density factor of approximately 95 is indicated very probably a sub-economic density factor for the period. To be an undoubted economic factor it would need to be at least twice the female HRF of 65, since the number of males covering an area is about equal to the number of females; and their average weight and population density about equal.

During fall the population had increased to one rabbit per 10 acres. Males weighing 1,406 grams and females 1,457 grams, the density factor is about 145. It may be slightly lower because of a large proportion of juveniles lighter in weight than adults, but in any case it too appears to be sub-economic in nature because it does not exceed twice the female autumn HRF of 100. Some of the territory studied was probably not being inhabited by cottontails or was used so infrequently by them that it was not measurable by the census methods used.

Comparison of Haugen's and Dalke's Population Density Data.—Dalke, 1943, furnished maps showing the yearly home ranges of male and female *Sylvilagus floridanus mallurus* (Thomas). Superimposing the male maps over the maps for females and calculating the territory occupied, showed that 49 mature cottontails occupied about 170 acres—a density of one cottonttail to 3.5 acres. Dalke could not show the home ranges of 64 others which overlapped the ranges of the 49 to some extent. In any case the year-long population density factor is considerably in excess of 410 or that for 49 individuals and much larger than Haugen's largest, 145.

Home Range.—Haugen, 1942b, discussing data from his previous paper, calculated the 2.5-acre squares surrounding his traps as representing a section of the home range of each cottontail caught there. In cases where the catches gave a U-shaped figure as part of the home pattern, he calculated the 2.5 acres partially enclosed by the U as part of the home range, assuming that the rabbit used it.

He provided detailed records of one female, number 449 which was captured first on May 13 and last on July 29, a total period of 79 days. During that period she occupied 25 acres, measured as described. This entire range was disclosed by the 67th day during which she was caught 10 more times.

If this female was of approximately average weight, her 65-day as well as her 79-day breeding season HRF was about 60.

Activity Range.—The data provided on her furnishes numerous additional sidelights on her daily and weekly range (Table 5).

TABLE 5

Length of census period (days)	2	3	4	5	6	7	8	9	10	11–19	62	79
Number of such census periods	16	15	14	13	12	11	10	9	8	28	1	1
Number of times caught during each census period	2	3	4	5	6	7	8	9	10	114	12	22
Average size of home range (acres)	7.3	10.5	10.9	12.3	14.8	15.2	15.8	17.2	17.2	17.5	17.5	25
Variation in size of revealed home range (acres)	2.5 to 10.0	7.5 to 12.5	7.5 to 12.5	10 to 12.5	12.5 to 17.5	12.5 to 17.5	15.0 to 17.5	15.0 to 17.5	15.0 to 17.5	—	—	—

1 Average

Between May 13 and May 22, when caught 5 times she had occupied 15 acres and her 10-day range (not HRF) factor was about 100.

Between July 11 and July 29, a period of 19 days, she was captured 17 times, which for certain statistical purposes is practically once a day, giving a basis for the preceding table.

Her average revealed 2-day range was 7.3 acres, based on sixteen 2-consecutive-day periods on which she was caught.

After this female was caught approximately 11 times during the first 11 days of censusing, her home range was fully revealed for the period. Although she was caught 8 more times, bringing the length of the period during which she was under observation in July to 19 days, her home range did not increase. It remained stable at 17.5 acres. Between May 18 and July 17, a period of 62 days, she was caught exactly 12 times. Her revealed home range was 17.5 acres, and did not increase during the following 12 days during which she was caught 5 more times. Haugen pointed out that approximately a dozen catches of an individual are likely to reveal the full extent of that individual's range.

This is true of course for relatively short term censuses, not complicated by seasonal drift or migration. To be effective the catches would have to be well distributed throughout the census.

That much depends upon distribution of catches during a census period is revealed by Dalke's 1942 data, tabulated in the preceding table, Table 6.

TABLE 6.—Relation of Length of Census Period and Revealed Size of Home Range Based on Dalke's Data.

MALES

Length of census period (days)	?	68*	140	194	355	394	283	294	?	?	67	81	388	?	137	154	346
Number of times caught	3	5*	5	5	5	5	7	8	9	9	10	10	11	14	15	20	38
Size of home range (acres)	1.1	0.6*	1.0	1.2	2.0	3.1	2.8	6.1	0.6	28	1 2	1.2	1.0	5.2	5.8	5.8	8.4

FEMALES

Length of census period (days).....	?	?	?	217	?	408	343	413	?	66	
Number of times caught.....	3	4	4	7	8	9	10	11	14	14	
Size of home range (acres).....	0.5	1.9	8.2	21.6	2.1	4.6	10.6	8.6	14.3	14.3	

These numbers were taken from Dalke's tables 25 and 28.

*These numbers were taken from Dalke's tables 26 27.

In those cases where several individuals were caught 5, 9 and 10 times each, the length of census period has been given from lowest figure to highest, i.e., 68 to 394, while the average size of home range is given in the same sequence because there was no means matching the data. This will not affect the discussion below even though it is probable that that correlation is not exactly the case.

Examination shows that twelve catches were not sufficient to measure the complete yearly range of cottontails. The ranges continued to increase with the number of times caught.

Comparison of Dalke's and Haugen's Home Range Data.—Dalke's and Haugen's methods of mapping and calculating home range data are so different that one must suspect widely differing results.

By Dalke's measurement the average female home range is 3 acres. By Haugen's, it is 13 acres or 4.3 times as great. By Dalke's measurement the average male home range is 9.6 acres. By Haugen's it is about 25 acres or 2.5 times as great. The method of grids, unless very small in relation to the minimum HR invariably gives the larger estimated range.

To put Dalke's and Haugen's estimates on somewhat the same basis, and to explain differences, 110-yard squares (Haugen's method) were drawn across Dalke's home range drawings, and polygons (Dalke's method) were drawn over Haugen's trapping-record maps. See Tables 7 and 8 for comparative results.

TABLE 7.—Comparison of Home Range Estimates Obtained by Using Haugen's Methods of Estimating Home Range over Dalke's Home Range Maps (Nearest complete acreage).

FEMALES

Dalke's method.....	8	6	6	6	5	3	3	3	2	2	1	1	1	1	1	0.6	0.6	Avg. 3
Haugen's method..	25	20	20	18	18	18	13	13	13	10	10	10	10	10	8	8	5	Avg. 13
Approximate difference (times)..	3	3	3	3	4	6	4	4	6	5	10	10	10	10	8	13	10	Avg. 4

MALES

Dalke's method	22	14	14	11	11	9	8	5	2	2	Avg. 9.6
Haugen's method	50	38	30	25	25	20	18	18	13	10	Avg. 25

TABLE 8.—Comparison of Home Range Estimates Obtained by Using Dalke's Method over Haugen's Data for Females.

No. of the individual.....	449	134	504	163	147	500	941	17	163	946	Average
Haugen's method (acres)	25	15	5	10	7.5	7.5	5	12.5	10	5	17.3
Dalke's method (acres)....	11	2	0*	0	0	0	0	3	0	0	5.3
Approximate difference....	14	13	–	–	–	–	–	10	–	–	12

*Dalke had set his traps irregularly in or near good cover. Therefore when catching an individual three times he found a measurable polygon. In the cases where 0 is recorded above, Haugen caught the individual in a straight line of traps only, which afforded no means of conversion to Dalke's method since it did not give a polygon for measurement.

Haugen's method gave the largest and most unpredictable estimates here as in the case of the opossum.

Effect of Size of Home Range on Differences Between Dalke's and Haugen's Estimates.—Reference to Table 7 also shows that in those cases where home range is largest, the difference between Dalke's and Haugen's method is generally least, for example 8 and 25 acres respectively or a difference of about three times. Where the size is smallest the difference is generally greatest, for example, 1 and 8 acres respectively or a difference of 8 times.

Effect of Shape of Home Range on Differences Between Dalke's and Haugen's Estimates.—This subject is not worked out in detail from data of the two authors. However, the relation is the same as for range of the opossum, Table 4, in which it is shown that where the home range is narrow, Haugen's method gives an estimate which is very much larger than the estimate based on minimum HR.

Primarily Spermivorous Species

EASTERN CHIPMUNK. *Tamias striatus lysteri* (Rich.).

Blair, 1942, live-trapped 154 chimunks on approximately 18.2 acres of virgin hardwood forest on the same area and by same methods used for woodland deermice. The census period covered 28 days beginning August 25. The 28-day population was eight to nine chipmunks per acre. His method for this species was the same as used for the wodland deermouse below. In fact, he studied the two species at the same time and place. He found that the average size of home ranges of adult females comprised about 2.2 acres; of adult males 2.3 acres; of immature females 1.8 acres; and of immature males 2.7 acres.

PINE SQUIRREL, *Tamiasciurus fremonti fremonti* (A. & B.).

Hatt, 1943, found five adult squirrels in a 10 acre tract of pure lodgepole pine in Colorado, remarking that this 'was indeed a small census," though lodgepole pine is the favored home of this squirrel.

At another point he found six adult squirrels and four nest-young on 25 acres of lodgepole.

Granting an average weight of 258.8 grams per squirrel, including young, the acre factors (AF) are respectively 130 and 105. The factor for six adults on 25 acres is approximately 60.

The above census was instantaneous in nature.

FOX SQUIRREL, *Sciurus niger rufiventer* (Geoff.).

Allen, 1942, studied fox squirrel populations by means of live-trapping in a Michigan woods composed chiefly of black oaks and white oaks, a habitat which was not of the best. His census area was 40 acres on which he operated 36 traps uniformly spaced so as to occupy plots slightly over 1 acre in size.

By supplementing his catch data with observations to determine how many of the squirrels caught were resident, he concluded that from January through April, 8 or 10 of the total of 12 caught were residents rather than drifts or migrants, concluded that in December about a dozen were residents.

Average male-female weights for the first period being about 756 grams, the per-acre factors are about 150 to 190. Having been about 774 grams in December, the factor is about 230 grams.

The above census as interpreted was essentially instantaneous in nature.

PRAIRIE DEERMOUSE, *Peromyscus maniculatus bairdii* (H. & K.).

Blair, 1940, estimated the average 3 weeks (he stated "monthly," but also wrote of basing his calculations on two alternate 1-week trapping periods which gives an over-all spread of 3-weeks) home range of 70 adult male prairie deermice to comprise an average of 0.63 acres; of adult females 0.51 acres. He used the grid method of trapping and calculating home ranges, the traps being set 60 feet apart. This would automatically make narrow long home ranges appear larger by comparison than compact home ranges (see discussion

for opossums above) and would also give larger estimates than would the 45-foot grids as for woodland deermice and chipmunks discussed in his 1942 paper.

It is further doubtful if Blair, in the case of each individual mouse, found the 3-weeks range because some of these range estimates were based on as few as three catches which, more than likely were more closely grouped in time than 3 weeks. They could have been as little as 3-day ranges.

The revealed range generally increases with time, at least to a certain point so that in those cases where a mouse was caught the first day and the last, its 21-day home range, other things being equal, would be larger than a 3-day range. Averaging these gives a heterogeneous result.

Because of these two variables, no comparison between this and other species is possible. There is no common denominator, either of duration of census period or grid size.

WOODLAND DEERMOUSE, *Peromyscus maniculatus gracilis* (LeC.).

Blair, 1942, caught 151 woodland deermice on an 18.2-acre plot of virgin forest in northern Michigan by setting live traps in a 45-foot grid pattern. Near the end of the census period a line of traps was set 90 feet distant around the margin of the plot, each trap in the outside square being 45 feet from adjacent traps. These were left five nights with the purpose of determining which residents of the plot had home ranges extending beyond the trapping limit. Each grid represented approximately 0.046 acre.

The plot itself was trapped for 28 days between August 25 and September 22, but only half the traps were set at any one time, alternating series of three lines each were set during alternate weeks. When a mouse was caught in the same trap on two consecutive nights that trap was left unset on the third night, allowing the individual freedom to move to some other part of its home range.

The traps were baited with sunflower seed, except during the last week when rolled oats and peanut butter were added without apparent change in effectiveness.

Home Range.—Blair's method of calculating home ranges was somewhat intermediate between that of minimum home range used by Dalke for cottontails and that of grids used by Haugen for cottontails.

TABLE 9.—Estimated Home Range (Acres).

Animal	Blair	Dalke	Haugen	Burt
a	1.3	0.7	0.7	0.5
b	2.1	1.3	1.2	1.0

It will be seen that in this case Blair obtains an estimate, Table 9, about twice as large as that obtained by Dalke's, Burt's, and Haugen's methods applied to his map. Although, in this particular case Haugen's method gives approximately the same answer as does Dalke's, this is due largely to shape of the range (compact rather than elongate) and the small size of the grids used

as compared with the minimum home range. The two factors of shape of estimated home range and relative size of grids used in estimating it give almost insurmountable obstacles to calculating a factor for converting one set of figures to another. Even if this could be done the varying lengths of time during which the home range was determined by Blair for each of the individuals would make comparison difficult due to the fact that the longer the period over which an individual was caught, the larger was the territory in which it was caught.

Populations.—Blair indicates 151 deermice caught on approximately 18.2 acres or a 28-day population of about 8 mice per acre. Some were probably not resident. Indications are that the area was not completely occupied hence this is in the nature of a sub-economic population for the area.

Home Ranges.—Blair remarks that adult *P.m. gracilis* home ranges are significantly larger than those of adult *P. m. bairdii.* This is due partly to the fact that ranges estimates of *gracilis* were based upon a heterogeneous census period up to only 10 days.

WOODMOUSE, *Peromyscus leucopus noveboracensis* (Raf.).

Blair, 1940, using the live-trapping method and 50-foot grids, estimated the average 10-day range of four adult females, three adult males, and three juveniles as 0.8 acres.

He pointed out that his estimated 10-day ranges were much larger than Burt's, 1940, estimates for the same species. This is definitely due largely to the fact that Blair used the grid method of calculating ranges and used relatively large grids. The results have no common denominator either as to time or method of estimating ranges because Blair's method automatically gives the larger home-range estimate.

Discussion, Table of Equivalent Populations

General.—Discussion of Table 1, is intended as an aid to elimination of blanks caused either by uninhabitibility or solely by lack of occupancy when censusing mammals.

In any censusing it should be well known that fluctuation of populations on a given area is due to increase or decrease of inhabitable portions of that area as well as to increase or decrease of numbers of individuals.

If census are to have any comparative value between species, blanks will have to be recognized and eliminated. Even if the intention back of a census be to compare fluctuations of populations from one period to another, the resulting census is likely to be more useful because of recognition of the effect of changing blanks, these being often very great.

Predatory Species.—Recognition of blanks is often most difficult but is perhaps surest in the case of direct observation or tracking. Marshall's 1936 map based on tracking, indicates that immediately after a snow four minks had used about 72 acres in their wanderings. If these averaged somewhere

around 920 grams, their weight per acre was around 60, more or less, for a day or two. It might be somewhat less in a week or a month, if the animals increased their wanderings, but as matters stand, the figure was about 60 for the days of observation.

Similarly, by tracking, Polderboer, Kuhn and Hendrickson, 1941, recorded that two weasels occupied a 5.5-acre weed patch; a single individual lived on a 10-acre patch of oat stubble and two others in a 28-acre field of sweet clover, all during winter and spring months. Altogether the five weasels occupied 43.5 acres. If they weigh about 430 grams their EDF (economic density factor) is about 50 or essentially the same as the 60 for minks.

This and similar figures for the gray fox (40), red fox (30) and coyote (50) indicate a close natural economic level well below 100 and perhaps commonly above 20 for relatively pure predators.

Insectivorous Species appear to maintain upper and lower levels quite similar to this. In the table only the four and eight *Blarina brevicanda* per acre with per-acre weights of about 80 and 160 are credited as being economic densities. Higher figures are tentatively classified as representing aggregations or rejected, Mohr, 1943, as not having been ascertained with sufficient accuracy. Burt indicates a possibility of 25 which would equal a factor of 500. For *Condylura cristata,* the figures 10 and 17 per acre with factors as high as 520 and 880 are credited. For *Parascalops breweri,* a population of 24 per acre with a factor as 1,225 high is probably in the nature of an aggregation.

The figure 880 is the highest credited for shrews and moles. It is doubtful if economic density factors are lower than about 60.

Armadillo factors based on populations recorded to date are exceptional in running much higher: from 530 to 4,355.

Skunks, largely insectivorous and easier to observe than shrews and moles, consistently run close to 200. All factors for skunks recorded in the table are regarded as economic figures.

Omnivorous Species appear to have factors constantly higher than those of most insectivores, the figures for possums, probably close to if not completely economic in nature, running from about 680 to 900 and of raccoons 1,160. The figure of 190 for possums is undoubtedly subeconomic in nature. (See discussion under possum.)

Herbivorous Species.—It is the more purely herbivorous species, the leaf, stem, and root-eating ones, whose factors run highest. Figures start in the low hundreds for ground squirrels to tens of thousands. Factors around 3,000 appear to be most common. Vole populations are commonly equally high.

Of the figures in the table population of voles below 8 to the acre, with and EDF of 320 are regarded as non-economic, indications being that if a given area is at all inhabitable it will carry at least four pairs and because female home ranges are recorded as about one-fourth acre and an equal number of males would cover it too.

Most of the figures for voles run about 2,000, or essentially the same as those for ground squirrels.

For the jackrabbits, only the population data furnished by Wooster appear to be of economic densities or near-economic densities. Their factors run from 760 to 2,340. For snowshoe rabbits the low figures are about the same while the higher run into scores of thousands. Most lie in the neighborhood of 1,000. Cottontail factors may run similarly.

Pocket gophers, among herbivores, consistently run low, the factors centering around 500-600 but reaching from 280 to 5,250. Perhaps this is due to nervous requirements which demand greater isolation than do most other species.

Spermivorous Species.—Those species which incline more to spermivorous diet for chief subsistence; chipmunks, squirrels, and deermice, run from about 70 to 2,000, most figures being from around 200 to 300. Among these jumping mouse factors appear to remain consistently at the lower levels.

Nearly all of the data used in the table of equivalent populations are those taken from the 1943 paper. Some changes were made due to error in the 1943 paper and others made as more accurate weights of individual mammals have been found.

Obviously, weights of mammals are not the same from place to place, down to the last gram. This however, does not essentially alter the mass weights per acre as used in the table.

Summary of Home Range Investigations Methods

Stickel, 1946, compared results of live-trapping and snap-trapping the woodmouse, *Peromyscus leucopus* in Maryland and concluded that currently accepted methods of interpreting snap-trapping data would have given erroneous and inflated results and that modern methods of live-trapping are valid for population studies. As indicated in the text above, accuracy of the latter method for home-range studies depends on methods of interpreting results including delimiting of the supposed home range.

The minimum home range method of estimating home ranges appear to give more consistent and reliable results than variations of the quadrat method.

Use of quadrats gives results varying directly with the size of the quadrat, the larger the quadrat in relation to the size of the real home range, the larger the area. Quadrats as large as 2.5 percent of the minimum home range of the opossum are, for example, probably too large.

Some method of moving live traps from place to place or keeping them inoperative for a portion of the range study period is desirable in order to overcome their tendency to restrict normal movements of animals.

Irregular and narrow home ranges are more easily overestimated than compact home ranges.

Home range factors, when based upon correct or near correct home range studies are generally considerably less than half as large as economic density factors for a given population at a given time and place.

REFERENCES

ALLEN, DURWARD L. 1942—Population and habits of the fox squirrel in Allegan County, Michigan. Am. Midl. Natur. **27**(2): 338-379.

BLAIR, W. FRANK. 1940—A study of prairie deer-mouse populations in southern Michigan. Am. Midl. Natur. **24**(2): 273-305.

———1942 Size of home range and notes on the life history of the woodland deer-mouse and eastern chipmunk in northern Michigan. Jour. Mamm. **23**(1): 27-36.

BURT, WILLIAM HENRY. 1940—Territorial behavior and populations of small mammals in southern Michigan. Misc. Publ. Univ. Mich. Mus. Zool. **45**: 1-58.

———1943—Territoriality and home range concepts as applied to mammals. Jour. Mamm. **24**(3): 346-352.

DALKE, PAUL D. 1942—The cottontail rabbits of Connecticut. State of Connecticut, Geological and Nat. Hist. Surv. Bull. **65**: 1-97.

ELTON, CHARLES. 1932—Territory among wood ants *(Formica rufa L.)* at Picket Hill. Jour. Animal Ecol. **1**(1): 69-76.

HATT, ROBERT T. 1943—The pine squirrel in Colorado. Jour. Mamm. **24**(3): 311-345.

HAUGEN, ARNOLD O. 1942—Home range of cottontail rabbit. Ecology **23**(3): 354-367.

———1942—Life history studies of the cottontail rabbit in southwestern Michigan. Am. Midl. Natur. **28**(1): 204-244.

KALMBACH, E. R. 1943—The armadillo: its relation to agriculture and game. Game, Fish, and Oyster Commission unnumbered bulletin: 1-61.

LAY DANIEL W. 1942—Ecology of the opossum in eastern Texas. Jour. Mamm. **23**(2): 147-159.

MOHR, CARL O. 1943—A summary of North American small-mammal censuses. Am. Midl. Natur. **29**(3): 545-587.

SCHEFFER, THEO. H. 1940—Excavation of a runway of the pocket gopher *(Geomys bursarius)*. Trans. Kansas Acad. Sci. **43**: 473-477.

SCOTT, THOS. G. 1943—Some food coactions of the northern plains red fox. Ecological Mono. **13**: 427-479.

STICKEL, LUCILLE F. 1946—Experimental analysis of methods for measuring small-mammal populations. Jour. Wildl. Mgmt. **10**(2):150-159.

TABER, WALLACE F. 1945—Contribution on the life history and ecology of the nine-banded armadillo. Jour. Mamm. **26**(3): 211-226.

ILLINOIS NATURAL HISTORY SURVEY,
URBANA, ILL.

Cayugoceras, an Upper Silurian Cephalopod

Rousseau H. Flower

The described Upper Silurian cephalopods are few in number, and among them are few strikingly diagnostic forms which have any potential value in correlation. In New York which has yielded most of the known forms, some poor orthoceracones, *Phragmoceras* and *Hexameroceras* occur in the Vernon shale. The Bertie waterlime has yielded some poorly preserved orthoceracones *Phragmoceras* and *Gomphoceras*. The Cobleskill limestone contains *Armenoceras, Ormoceras, Protokionoceras, Tetrameroceras, Phragmoceras,* and the diagnostic trochoceroids *Mitroceras* and *Foersteoceras*. The Manlius cephalopods are poorly known, but show a continuation of *Ormoceras,* which, indeed, persists into the Coeymans limestone of the Devonian, the diagnostic *Herkimeroceras,* and a few poorly preserved orthoceracones of as yet uncertain position. Among these types only three of the genera, *Mitroceras, Foersteoceras* and *Herkimoceras,* appear to be confined to the Upper Silurian. These have little practical value for with the exception of some poorly preserved specimens assigned to *Mitroceras* from the Akron and Detroit River beds of Ontario and Ohio, they are known only from New York. The genus *Cayugoceras,* described below, is the only genus recognized which is common to the Cayugan of New York and the approximately equivalent horizon F2 of the Silurian of Bohemia. The genus is connected genetically with the widespread Middle Silurian *Mandaloceras* Hyatt by a group of Bohemian Middle Silurian species for which the generic name *Ovocerina* is here proposed.

Cayugoceras Flower, n. gen.

Pl. 1, Figs. 4-7

Genotype: *Gomphoceras semiclausum* Barrande (1865 pl. 88, fig. 12-15).

This genus is characterized by the spheroidal gibbous living chamber which contracts to a nearly circular aperture. The early part of the shell is unknown, but is apparently cyrtoconic and rapidly expanding. The basal two-thirds of the living chamber are sphaeroidal, terminating in a faint constriction of the interior, beyond which the remainder of the living chamber is somewhat conical, contracting, though less rapidly than before, to the aperture. One side, assumed to be the venter is more strongly convex than the other; here the internal constriction is negligible. The dorsum is strongly convex over the lower part of the living chamber, and then produced, and approaches the venter less rapidly over the adoral third. The lateral profile shows the gibbous basal portion, a constriction, and an adoral subconical portion. The cross section in the genotype is faintly depressed, the dorsum more flattened than the venter. The siphuncle lies about half way between the venter and the center of the shell. Its structure is unknown. The sutures, faintly indicated at the base

of the living chamber, appear to be essentially straight and transverse. The aperture in the genotype is depressed, the dorsal side rounded, the ventral side subangular, so that the aperture is very strongly reminiscent of that of the Middle Devonian genus *Micronoceras*, and also of *Ovoceras*.

On the basis of an exogastric interpretation, this shell is comparable to the Devonian genera *Ovoceras* Flower (1936) and *Micronoceras* Flower (1938). It resembles *Ovoceras* more in the form of the conch, but lacks the small rounded conspicuous hyponomic sinus. It resembles *Micronoceras* more in the simplicity of the aperture, but differs in retaining a definitely exogastric rather than an essentially straight shell. Further, it differs from both genera in possessing a relatively large siphuncle which lies far from the center. Both *Micronoceras* and *Ovoceras* have small siphuncles composed of relatively slender segments, which are located close to the ventral margin of the shell. *Micronoceras* and *Ovoceras* are confined to the Devonian and have been placed in the family Brevicoceratidae (Flower, 1945). The relationship of *Cayugoceras* to these genera is, from this evidence, only homeomorphic.

Probably *Cayugoceras* is related to a group of Middle Silurian species known largely from Bohemian representatives, including the genera *Mandaloceras* Hyatt and *Clathroceras* Foerste (see Foerste, 1926). *Mandaloceras* is a nearly straight faintly exogastric shell with a T-shaped aperture. The siphuncle is large and lies between the venter and the center of the shell. *Clathroceras* is a markedly exogastric brevicone with a small ventral siphuncle, an aperture essentially similar to that of *Ovoceras*, in possessing a rounded main aperture with a small rounded hyponomic sinus projecting on the ventral side, but is unique in its ornamentation of fine transverse lirae and striae crossed by larger and more prominent longitudinal lirae.

Still more similar to *Cayugoceras*, is a group of Middle Silurian species from Bohemia typified by *Gomphoceras transversum* Barrande (1865, pl. 106, fig. 1-4). These species lack the fasciculate ornamentation of *Clathroceras*, but agree with that genus in the form of the aperture. They resemble *Mandaloceras* in the shell form, and in having a siphuncle which is relatively large at the septal foramen, and which lies between the center and the venter, but is not typically marginal in position. They differ from *Mandaloceras* in that the main part of the aperture is rounded rather than a transverse slit. They differ from *Cayugoceras* in the prominence of the hyponomic sinus of the aperture. However, this group of species supplies a logical connection between *Cayugoceras* and *Mandaloceras*. These species seem to be without any adequate generic resting place, and the name *Ovocerina* is proposed for them below.

The species assigned with certainty to *Cayugoceras* include only the genotype, *C. semiclausum* (Barrande) which is refigured in Pl. 1, fig. 4-7, and the new species *C. manni* from the Cobleskill limestone of New York. The little known *Ovoceras ovoides* Hall (1859-1861, p. 342, pl. 69, fig. 2a-b,) of the Manlius limestone of Litchfield, Herkimer Co., New York, may prove to belong to *Cayugoceras* when it is better known. At present all that can be said of the species is that its general form is not inconsistent with placing it in

Cayugoceras, but information concerning the aperture is insufficient to warrant generic determination. The type consists of one half of a shell, the opposite side having been ground down to a plane showing the septa. Even the orientation of the specimen is uncertain.

Cayugoceras manni Flower, n. sp.

Pl. 1, Figs. 1-3

This species is based upon a living chamber, the base of which is obscure. The living chamber has a length of 31 mm., is strongly compressed, gibbous basally. The assumed venter slopes centrad strongly as it approaches the aperture, but is strongly curved basally, becoming straight as it approaches the aperture. The constriction of the interior of the shell is hardly perceptible on the ventral profile. The sides are strongly rounded below, faintly constricted laterally, and then approach each other more gradually as they approach the aperture. The dorsum is missing basally, but was apparently rounded in profile prior to the internal constriction. Adorally it is nearly straight as it approaches the aperture, and is much less strongly inclined to the axis of the conch than is the venter. The aperture is clearly preserved, and is a compressed oval, the dorsum slightly more narrowly rounded than the venter. No trace of the septum at the base of the phragmocone, the sutures or the siphuncle, are preserved. The surface shows only faint traces of lines of growth.

The aperture is 19 mm. wide and 30 mm. high; 17 mm. lower, the conch has a width of 40 mm. and a height of 50 mm. The base has estimated measurements of 55 mm. and 45 mm., 31 mm. before the aperture.

Discussion.—This species differs materially in shape and size from the genotype. The compressed rather than depressed section appears to be original though it is not impossible that some compression by disortion may have occurred. However, the general regularity of form of the shell indicates that such distortion was probably very minor. The aperture is a compressed oval, and not depressed. Further, the assumed ventral outline is, if anything, slightly more broadly rounded than that of the dorsum. Gibbosity lay lower on the living chamber in this species, and it lacks the marked spheroidal contraction of the lower part of the living chamber which is characteristic of the genotype. The ventral profile is less rounded adapically and straight over a longer distance as it approaches the aperture.

Some of these differences might readily be considered of greater than specific rank, in particular the compression of the shell, and the compressed oval of the aperture. However, the two species are so manifestly similar in aspect, and so widely different from other brevicones, that their relationship is strongly indicated. This is further supported by their approximate equivalence in age.

Type.—Holotype, New York State Museum.

Occurrence.—From the Cobleskill limestone, Schoharie, New York.

Ovocerina Flower, n. gen.

Genotype: *Gomphoceras transversum* Barrande

Conch breviconic, faintly exogastric, cross section varying from faintly compressed to faintly depressed. Sutures essentially straight and transverse, siphuncle located between center and venter, never marginal, composed usually of relatively broad short cyrtochoanitic segments. No internal organic deposits are recognized within the siphuncle with certainty. The living chamber contracts orad, being more or less dome-like, to the aperture which is an oval interrupted on the ventral side by a rounded hyponomic sinus.

Discussion.—The species for which this genus is erected differ from *Mandaloceras* in that the main part of the aperture is rounded instead of transverse. Some apertures tend to be slightly broadened, and in this feature a separation from *Mandaloceras* may be considered arbitrary. However, typical *Ovocerina* is so different in aspect from typical *Mandaloceras* that a new generic name for the group of species is needed. The evidence suggests that there is a real relationship between the two genera. This is supported not only by the similarity of the apertures, but by the fact that the siphuncles are always large at the septal foramen and are considerably removed from the ventral wall of the shell. There appears to be some variation in the form of the siphuncle. Further study may prove that such differences are sufficient to warrant subdivision of *Ovocerina*. *O. alphaeus* (Barrande, pl. 83, fig. 6-9) shows a siphuncle composed of *Armenoceras*-like segments. Also, curiously, the basal segment shown in figs. 8 and 9 is higher and narrower than the others, and the ontogenetic progression of the siphuncle is here faintly reminiscent of that seen in the early portions of ascoceroids. Perhaps here, as in the asoceroids, natural truncation may account for the absence of early stages of these cephalopods. On the other hand, *Gomphoceras belloti* Barrande (Pl. 82, fig. 6), a species which is atypical in being compressed, but has the aperture and form of *Ovocerina*, possesses a *Dolorthoceras*-like siphuncle in the early stages, the segments becoming slightly broader adorally.

This genus resembles *Ovoceras* Flower (1936) of the Devonian, strongly in form and aperture. However, that genus has a small marginal siphuncle composed of narrow and only faintly expanded segments. In *Ovocerina* the segments of the siphuncle are always larger, and the siphuncle is always markedly removed from the ventral wall of the shell.

In this genus I place the following of the species described by Barrande: *O. transversum* (Barrande, Pl. 106, fig. 1-4), *O. alphaeus* (Pl. 83, fig. 1-9), *O. ferum* (Pl. 80, fg. 18-22), *O. spei* (Pl. 82, fig. 7-9), *O. gracile* (Pl. 105, fig. 1-4), *O. porrectun* (Pl. 89, fig. 1-6), *O. belloti* (Pl. 72, fig. 4-5), *O. sphaerosoma* (Pl. 104, fig. 10-12), *O. microstoma* (Pl. 72, fig. 7-17), *O. atrophum* (Pl. 79, fig. 17-23), *O. strigatum* (Pl. 75, fig. 18-21).

Cayugoceras, described above, is probably an Upper Silurian modification of this genus. It differs in the loss of the hyponomic sinus.

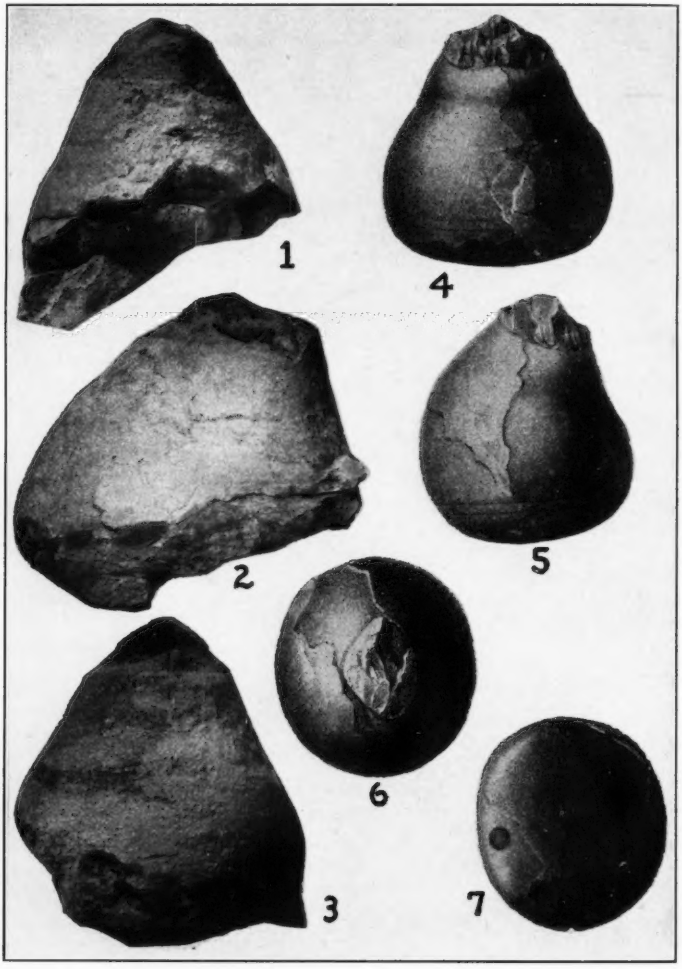

PLATE I

Figs. 1-3.—*Cayugoceras manni* Flower, n. sp. Holotype, ×1. (1) dorsal, (2) left lateral and (3) ventral views. Cobleskill limestone, Schoharie, N. Y.

Figs. 4-7.—*Cayugoceras semiclausum* (Barrande) Holotype (by monotypy) after Barrande, ×1. (4) dorsal, (5) lateral, dorsum on right, (6) adoral and (7) septal views. Horizon F2, Silurian, Mnenian, Bohemia.

REFERENCES

BARRANDE, J. 1865-1877—Système Silurien du centre de la Bohême. Vol II. Céphalopodes. Prague.

FLOWER, R. H. 1936—Cherry Valley cephalopods. Bull. Amer. Paleont. **22**(76):1-96, pls. 1-9.

———1938—Devonian brevicones of New York and adjacent areas. Paleontographica Americana **2**(9):84, 4 pls., 10 figs.

———1945—Classification of Devonian nautiloids. Amer. Midl. Nat. **33**:675-724, pls. 1-4.

FOERSTE, A. F. 1926—Actinosiphonate, trochoceroid and other cephalopods. Denison Univ. Bull., Sci. Lab., Jour. **21**:285-384, pls. 32-53.

HALL, J. 1859-1861—Paleontology of New York. Vol. 3. Containing descriptions and figures of the organic remains of the lower Helderberg group and the Oriskany sandstone. Albany.

HYATT, A. 1900—Cephalopoda. *In* Zittel-Eastmann, Textbook of Paleontology, Vol. 1, 1st ed., pp. 502-592. (Reprinted 2nd ed., 1913, pp. 583-618.)

N. Y. STATE MUSEUM,
ALBANY, N. Y.

Book Reviews

PRAIRIE WINGS.—Pen and Camera Flight Studies by Edgar M. Queeny. Explanatory Sketches by Richard E. Bishop. Ducks Unlimited, New York, 1946, 256 pp., 276 photos, 140 sketches. $15.00.

Ducks Unlimited is to be congratulated upon bringing out this book and Mr. Queeny for his generosity in turning over its proceeds to them.

The author has given us in this volume some of the best photographs of ducks that have ever been published. In so doing he has shown some tricks of flight not before known as far as the reviewer can determine. Such is the series of shots of the mallard drake using his wings against the water to give him his initial spring into the air (pages 44 to 46). It would be interesting to know whether a small duck like the Green-winged Teal does the same. Mr. Bishop's frontispiece in color and his sketches add much to this very fine book.

My only criticisms are the following. In reading the chapters "The Secrets of Pinions" and "Instruments of Flight" one is given the impression that most or all of the flight maneuvers are performed consciously by the ducks whereas much must be instinctive or even mechanical. Under the latter category would come the closing of the primaries on the down stroke and the opening of the same on the up stroke of the wing. If one examines the way the flight feathers overlay each other it is readily seen that on the down beat the pressure of the air on the underside of the wing tends to hold them together while the opposite is true when the wing is raised and the air pressure is on the upper surface. Also it is unfortunate that Mr. Queeny did not consult some competent ornithologist before going into the ornithological questions on page 247. If he had I am sure his answers on whether there is a red and a yellow legged mallard and the distinction between the male and female black ducks would have been different.—BOARDMAN CONOVER, Chicago Natural History Museum.

BIOLOGICAL SURVEY OF THE MOUNT DESERT REGION. Part 7, The Insect Fauna. By William Procter, Wistar Institute, Philadelphia, 1946. 566 pp., illustrated.

The publication of the first report on the Insects of Mt. Desert (Biol. Surv. Mt. Desert Region, Part 1, 1927), acted as a stimulant to those who are and have been interested in its fauna. In 1927, a total of 3,384 species of insects were known to inhabit the area, in 1938 a revised edition (Op. Cit., Part 6, 1938) included data on 1,968 additional forms of insects and 113 Arachnids. The present second revision of the report adds another 1,026 insects and 87 Arachnids, making a grand total of 6,378 species of insects and 200 species of pseudoscorpions, spiders, harvestmen and mites. It is of interest to note that in the original list it was estimated that the total number of insects in the region might reach the total of 5,000.

The work is definitely not a mere list of names; for each species (or genus if the contained species have similar habits) there is a statement of what is known of its food and habitat. It is inevitable that many species in the collection will be represented only by specimens taken at light or in random sweeping so that one should not expect biological data on all species.

Certain families, such as the Tipulidae in the Diptera, have been intensely studied; other groups, for instance the subfamily Aleocharinae, have been neglected because of the fact that there is no one to make authoritative determinations. No water mites are recorded, it is hardly possible that there are less than 30 species on the island. But when one compares the figures of 16,124 (species and varieties known (1928) from New York State) with 6,378 for this relatively small area, one is convinced that Dr. Procter and his associates have done an extraordinary piece of work.—E. A. CHAPIN, U. S. National Museum, Washington, D. C.